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VENTURE CAPITAL INVESTMENTS IN ARTIFICIAL INTELLIGENCE

ANALYSING TRENDS IN VC

IN AI COMPANIES FROM 2012

THROUGH 2020

OECD

BETTER POLICIES FOR BETTER LIVES

Foreword

This report provides analysis and insights on venture capital (VC) investments in private companies that are focused on artificial intelligence (AI), based on private-source data. It is a contribution by the Working Party on Measurement and Analysis of the Digital Economy (MADE) to the work programme of the Committee on Digital Economy Policy (CDEP). This publication is part of the Digital Economy Papers series and will be published on OECD i-Library and the associated data available in real-time on the OECD.AI Policy Observatory (www.oecd.ai/). It was drafted by Roland Tricot (Consultant to the OECD) with input and support from Besher Massri and Marko Grobelnik from the AI Lab of the Slovenian Jožef Stefan Institute and from the OECD: Vincenzo Spiezia, Audrey Plonk, Sarah Box, Andrew Wyckoff, Dirk Pilat, Karine Perset, and Luis Aranda. The publication's quality benefited greatly from their engagement. Comments and suggestions by delegates from Korea, Mexico and Russia are gratefully acknowledged. The author is also grateful to Douglas Frantz (Consultant to the OECD) and to Louise Hatem and Angela Gosmann from the OECD for editorial support.

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Note to Delegations:

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Note by all the European Union Member States of the OECD and the European Union: The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

TABLE OF CONTENTS

Tables

Figures

Executive summary

New analysis of global investments by venture capitalists in private companies focused on artificial intelligence (AI) found investments in AI to be growing at a dramatic pace. The United States (US) and the People's Republic of China (hereafter "China") are leading this wave of investments that tend to concentrate on a few key industries. The data showed that the European Union, Britain, and Japan increased investments, but lag behind the two dominant players.

The study analysed venture capital (VC) investments in 8 300 AI firms worldwide, covering 20 549 transactions between 2012 and 2020, based on data provided by Preqin, a private capital-markets analysis firm in London. The data did not capture every deal and required some extrapolation, and the data does not cover the internal investments in AI made by public companies. But the timeliness of the findings provides a valuable source of information as national governments, international organisations and the public and private sectors develop policies and strategies to capture the benefits of AI for all. In the present report, an 'AI start-up' or 'AI firm' is considered to be a private company that researches and delivers all or part of an AI system or researches and delivers products and services that rely significantly on AI systems. 'AI start-up' and 'AI firm' have the same meaning in the report. The definition of an AI system follows that of the OECD AI Principles: "*An AI system is a machine-based system that is capable of influencing the environment by producing an output (predictions, recommendations or decisions) for a given set of objectives. It uses machine and/or human-based data and inputs to (i) perceive real and/or virtual environments; (ii) abstract these perceptions into models through analysis in an automated manner (e.g., with machine learning), or manually; and (iii) use model inference to formulate options for outcomes. AI systems are designed to operate with varying levels of autonomy*" (OECD, forthcoming[1]).

GROWTH OF VC INVESTMENTS IN AI

The global annual value of VC investments in AI firms has grown dramatically, from less than USD 3 billion in 2012 to close to USD 75 billion in 2020. Investments increased 20% last year alone. Start-up firms based in the United States and China absorbed more than 80% of investments in 2020. The European Union followed, with 4% and the United Kingdom and Israel, both at 3%. Within the EU, AI firms based in Germany and France accounted for about two thirds of VC investments both in 2020 and since 2012.

Growth in AI investment in US-based firms has been steady from 2012 onwards, reaching USD 42 billion in 2020 (57% of the total). Investment in Chinese firms experienced a spike in 2017 and 2018, followed by a slump in 2019, representing USD 17 billion in 2020 (24%). VC investment in AI was distributed across more firms in the US than in China; the latter having more very large deals involving fewer firms.

The venture capital sector tends to forerun general investment trends, indicating the AI industry is maturing. As the AI industry matures, the median amount per investment is growing, there are more very large investments and proportionately fewer investment deals at early stages of financing.

VC INVESTMENTS BY INDUSTRY

Following investment flows helps identify hotspots for AI in the economy. Based on the data, the analysis identified AI firms in the three economic sectors that attracted the largest amount of investment:

- AI companies working on driverless vehicles and related mobility technologies attracted the most investments, drawing USD 19 billion of VC money in 2020 and USD 95 billion from 2012 to 2020. Those figures demonstrate the belief in AI's huge potential to solve critical mobility and transportation challenges in future. Nearly all of those investments – 98% – were made in companies in China and the United States.

- The second-biggest sector for VC investment was healthcare, drugs and biotechnology, which attracted 16% of the total in 2020. Investments in these related industries doubled from USD 6 billion in 2019 to USD 12 billion in 2020, at least partly due to the COVID-19 pandemic.

- The broad category of business processes and support services ranked third in VC investments in 2020, accounting for 11% of the total. The level of investment reflected the growing recognition of the role AI can play in creating more efficient and cost-effective processes for business and government and the increase in automation.

Except for mobility and autonomous vehicles – a priority in both the US and China – VC investments in US, Chinese and EU27 AI firms targeted different industrial sectors:

- For AI start-ups based in the US the top industries were: mobility and autonomous vehicles (30% between 2012 and 2020); healthcare (13%); business processes and support services (11%); IT infrastructure and hosting (10%); and media, social platforms and marketing (8%); and financial and insurance services (7%).

- For Chinese AI start-ups the top industries were more focused: mobility and autonomous vehicles (41% of VC investments from 2012 to 2020); media, social platforms and marketing (14%); robots, sensors and IT hardware (13%); IT infrastructure & hosting (8%); and business processes and support services (7%).

- In the EU27, the top 5 industries between 2012 and 2020 were: media, social platforms and marketing (20%); business processes and support services (19%); financial and insurance services (16%); IT infrastructure and hosting (13%); and, healthcare, drugs and biotechnology (12%).

VC INVESTORS IN AI

US VC investors were the most active investors in AI firms, representing 43% of the worldwide value of VC investments in AI in 2020, followed by Chinese investors (20%) and then EU27 investors (9%).

The US and China were net beneficiaries of AI VC investment from 2012 to 2020, *i.e.* American and Chinese AI firms funnelled more VC funds than US and Chinese VC investors distributed; while the opposite was true for the EU27, Japan, the UK and the rest of the world.

Both US and Chinese VC investors are dominant actors in their respective national market but hold decreasing shares of each other's market. Chinese VC investors seemed more focused on China, investing only 16% of funds outside China between 2016 and 2020,

while US VC investors invested 23% of funds outside the US. As a result, while Chinese VC investors represented 3% of AI VC investment in the US and 4% in the rest of the world in 2020, US VC investors represented 10% of AI VC investment in China and 23% in the rest of the world.

Synthèse

Une nouvelle analyse des investissements effectués au niveau mondial par des sociétés de capital-risque dans des entreprises privées dont l'activité se focalise sur l'intelligence artificielle (IA) révèle une croissance spectaculaire des investissements en IA. Cette vague d'investissement est d'abord impulsée par les États-Unis et la République Populaire de Chine (ci-après, « Chine ») et se concentre sur quelques d'industries clés. Les données montrent également une augmentation des investissements effectués par l'Union Européenne (UE), la Grande-Bretagne et le Japon, qui restent néanmoins en deçà des deux acteurs dominants.

L'étude analyse des investissements en capital-risque dans 8 300 entreprises d'IA à travers le monde, soit 20 549 transactions entre 2012 et 2020, issues de la base des données fournies par Preqin, une société d'analyse des marchés de capitaux privés à Londres. Certains des résultats ont été extrapolés, les données ne couvrant pas toutes les transactions. En outre, les données n'incluent pas les investissements en IA faits en interne par des entreprises listées. Néanmoins, le caractère récent de ces résultats constitue une source d'information précieuse, à l'heure où gouvernements, organisations internationales, secteurs public et privé tentent d'élaborer des politiques et des stratégies à même de diffuser les bénéfices de l'IA aussi largement que possible.

Dans le cadre de cette étude, une « start-up d'IA » ou « entreprise d'IA » est définie comme une entreprise privée qui développe et fournit tout ou partie d'un système d'IA ou des produits et services qui reposent en grande partie sur des systèmes d'IA. Les termes « start-up d'IA » et « entreprise d'IA » sont utilisés de façon interchangeable tout au long du rapport. Le rapport utilise la définition d'un système d'IA proposée par les Principes de l'OCDE sur l'IA, selon laquelle : "*Un système d'IA est un système basé sur une machine qui est capable d'influencer son environnement en produisant un résultat (prédictions, recommandations ou décisions) pour un ensemble donné d'objectifs. Il utilise des données et des intrants générés par la machine et/ou fournis par l'homme afin de (i) percevoir des environnements réels et/ou virtuels ; (ii) abstraire ces perceptions en modèles par une analyse automatisée (par exemple, avec l'apprentissage automatique) ou manuelle ; et (iii) utiliser les déductions faites par le modèle pour formuler des options de résultats. Les systèmes d'IA sont conçus pour fonctionner avec différents niveaux d'autonomie.*"

CROISSANCE DES INVESTISSEMENTS EN CAPITAL-RISQUE DANS L'IA

La valeur annuelle mondiale des investissements de capital-risque dans les entreprises d'IA a connu une croissance spectaculaire, passant de moins de 3 milliards en 2012 à près de 75 milliards de dollars en 2020. Les investissements ont augmenté de 20% au cours de la seule année passée. Les start-up basées aux États-Unis et en Chine ont concentré plus de 80% des investissements en 2020, suivies par celles de l'Union Européenne, avec 4%, le Royaume-Uni et Israël, avec 3% chacun. Au sein de l'UE, les entreprises d'IA basées en Allemagne et en France ont représenté environ deux tiers des investissements en capital-risque, en 2020 et depuis 2012.

L'investissement en IA dans les entreprises basées aux États-Unis a cru à une vitesse constante depuis 2012, pour atteindre 42 milliards de dollars en 2020 (57% du total). À l'inverse, les investissements dans les entreprises chinoises ont connu un pic en 2017 et

2018, suivi d'un effondrement en 2019, représentant 17 milliards de dollars en 2020 (24% du total). En outre, les investissements en capital-risque dans l'IA se sont répartis entre un plus grand nombre d'entreprises aux États-Unis qu'en Chine, cette dernière affichant davantage de très larges opérations impliquant moins d'entreprises.

Le secteur du capital-risque tend à précéder les tendances générales d'investissement, donnant des signes de maturation de l'industrie de l'IA. À mesure que l'industrie de l'IA gagne en maturité, le montant médian par investissement augmente ainsi que le nombre de très larges transactions avec proportionnellement moins de transactions aux premiers stades de financement.

INVESTISSEMENT DE CAPITAL RISQUE PAR INDUSTRIE

L'étude des flux d'investissement permet d'identifier les secteurs les plus attractifs pour l'IA. Grace aux données, l'analyse a identifié les trois secteurs économiques qui ont attiré le plus d'investissement:

- Les entreprises d'IA travaillant sur les véhicules autonomes et les technologies de mobilité en lien ont attiré le plus d'investissements, bénéficiant de 19 milliards de dollars de capital-risque en 2020 et 95 milliards de dollars de 2012 à 2020. Ces chiffres démontrent une certaine croyance dans l'énorme potentiel qu'a l'IA pour résoudre des problèmes critiques de mobilité et de transport à l'avenir. La quasi-totalité de ces investissements - 98% - ont été réalisés dans des entreprises en Chine et aux États-Unis.

- Le deuxième secteur le plus important pour les investissements en capital-risque est celui de la santé, des médicaments et des biotechnologies, qui a attiré 16% du total en 2020. Les investissements dans ces industries liées ont doublé, passant de 6 milliards de dollars en 2019 à 12 milliards de dollars en 2020, en partie du fait de la pandémie de COVID-19.

- Les processus d'entreprises et les fonctions support, une catégorie large, se sont hissés au troisième rang des secteurs les plus investis par le capital-risque en IA en 2020, représentant 11% du total. Ce niveau d'investissement reflète la reconnaissance croissante du rôle que l'IA peut jouer dans la création de processus plus efficaces et plus rentables pour les entreprises et les gouvernements, ainsi que les progrès de l'automatisation.

À l'exception de l'industrie de la mobilité et des véhicules autonomes, qui a été une priorité commune aux entreprises d'IA aux États-Unis et en Chine, les investissements de capital-risque ont ciblé des secteurs industriels différents aux États-Unis, en Chine et dans les pays de l'UE:

- Pour les start-up d'IA basées aux États-Unis, les cinq secteurs les plus dynamiques ont été: la mobilité et les véhicules autonomes (30% entre 2012 et 2020) ; la santé (13%) ; les processus d'entreprise et fonctions support (11%) ; l'infrastructure informatique et d'hébergement (10%) ; les médias, plateformes sociales et marketing (8%) ; et les services financiers et d'assurance (7%).

- Pour les start-up d'IA basées en Chine, les cinq premiers secteurs se sont révélés être ceux de la mobilité et des véhicules autonomes (41% des investissements en capital-risque de 2012 à 2020), les médias, les réseaux sociaux et le marketing (14%), la production de robots, de capteurs et de matériel informatique (13%), l'infrastructure et

l'hébergement informatiques (8%) et les processus d'entreprise et fonctions support (7%).

- Dans l'UE, les cinq principaux secteurs d'activité ciblés entre 2012 et 2020 ont été les médias, les plateformes sociales et le marketing (20%) ; les processus d'entreprise et fonctions support (19%); services financiers et d'assurance (16%) ; infrastructure informatique et hébergement (13%) ; et la santé, les médicaments et les biotechnologies (12%).

LES INVESTISSEURS EN IA

Les investisseurs en capital-risque américains ont été les plus actifs dans le domaine de l'IA, étant à l'origine de 43% de la somme totale investie en capital-risque dans l'IA en 2020, suivis par les investisseurs chinois, puis par les investisseurs de l'Union Européenne.

Entre 2012 et 2020, les entreprises d'IA basées aux États-Unis et en Chine ont été des bénéficiaires nets, c'est-à-dire qu'elles ont attiré plus de fonds de capital-risque que le pays n'en a investi dans des entreprises d'IA à l'étranger. L'inverse était vrai pour l'UE, le Japon, le Royaume-Uni et le reste du monde.

Les investisseurs en capital-risque américains et chinois ont su conserver une position dominante sur leurs marchés intérieurs respectifs au détriment de leurs positions sur les marchés étrangers, et notamment l'un chez l'autre. Les investisseurs en capital-risque chinois se sont particulièrement focalisés sur leur marché domestique, n'investissant que 16% de leurs fonds en dehors des frontières nationales entre 2016 et 2020, tandis que les investisseurs en capital-risque américains ont investi 23% de leurs fonds en dehors des États-Unis. Par conséquent, quand les investisseurs chinois représentent seulement 3% des investissements de capital risque en IA aux États-Unis et 4% dans le reste du monde en 2020, les investisseurs américains détiennent 10% du capital risque investi en IA en Chine et 23% dans le reste du monde.

Introduction

In 2020, the OECD launched OECD.AI, the OECD Artificial Intelligence Policy Observatory, to inform policy makers in their policy responses to developments in AI. The AI Policy Observatory facilitates dialogue between stakeholders and provides multidisciplinary, evidence-based policy analysis, supported by data and metrics on AI. One of the newest metrics planned to be featured on OECD.AI is up-to-date estimates of venture capital (VC) investments in private companies focused on AI.

The present report is a contribution by the Working Party on Measurement and Analysis of the Digital Economy (MADE) to OECD.AI. It provides analysis and insights into VC investments in private companies focused on AI.

VC investments tend to finance private companies that are not quoted on the stock market and are often in early development phase. VC investments can be a good proxy to help understand which countries and industries are attracting investments in AI for the following reasons: 1) firms raise VC to invest into their development; 2) private firms that attract VC tend to be firms with a narrower business focus that are not yet diversified; 3) VC is an industry of its own with multiple actors documenting VC transactions worldwide, which make VC investments easier to analyse than internal corporate investments. However, using VC to analyse investments in AI also has limitations including: 1) initial VC investments are sometimes not reported until companies seek out further rounds of funding; 2) VC investment amounts are not always disclosed; 3) some countries rely on start-ups or spin-offs of larger firms to innovate and on VC to fund the start-ups, while in other countries innovation is conducted within the R&D department of larger firms.

The paper is organised as follows. Section 1 describes the dataset used and explains the approach taken to identify "artificial intelligence" firms. Section 2 reviews estimates of AI VC investment by country and over time. Section 3 reviews AI VC investments by industry. Section 4 analyses the investors that are involved in AI VC deals. An appendix follows with additional information on the data and the methodology used.

The dataset

This report provides estimates of venture capital (VC) financial investment in AI firms worldwide based on private-source data from Preqin, extracted on 23 April 2021, processed by the AI lab of the Jožef Stefan Institute, Slovenia and analysed by the OECD. Preqin is a private company, founded in 2003, which collects data regarding private equity transactions, funds and fund managers. The Jožef Stefan Institute is the leading Slovenian scientific research institute and its AI lab processed the Preqin data to categorise it by country and industry and estimate missing amounts.

Data on VC "deals" provided by Preqin includes information on the firm raising VC investments as well as on the deal itself and on the investors. Information about the firm include the name of the company, the country where it is located, the year it was established, a description of its activities, a classification of the industries where the firms operate, as well as a set of cross-industry classifications, labelled "verticals". Information about the deal include the date, the stage, e.g. seed funding, round A, etc., and the amount of the deal. Information about the investors include their name and the country where they are located.

The analysis was carried out on approximately 170 000 VC deals reported to have taken place between 2012 and 2020. Of those deals, 20 942 were categorised as VC investments concerning AI firms/start-ups. In the present report, an AI firm/start-up is considered to be a private company that researches and delivers all or part of an AI system or researches and delivers products and services that rely significantly on AI systems. The definition of an AI system follows that of the OECD AI Principles: "*An AI system is a machine-based system that is capable of influencing the environment by producing an output (predictions, recommendations or decisions) for a given set of objectives. It uses machine and/or human-based data and inputs to (i) perceive real and/or virtual environments; (ii) abstract these perceptions into models through analysis in an automated manner (e.g., with machine learning), or manually; and (iii) use model inference to formulate options for outcomes. AI systems are designed to operate with varying levels of autonomy*" (OECD, forthcoming[1]).

Start-ups are identified as AI start-ups based on Preqin's manual categorisation (those represent 84% of the monetary value of transactions included), as well as on OECD's manual categorisation (2% of the monetary value of transactions included) and OECD's automated analysis of the keywords contained in the description of the company's activity categorisation (14% of the monetary value of transactions included). Keywords used are of three kinds: generic AI keywords, such as "artificial intelligence" and "machine learning"; keywords pertaining to AI techniques, such as "neural network", "deep learning", "reinforcement learning"; and keywords referring to fields of AI applications, such as "computer vision", "predictive analytics", "natural language processing", "autonomous vehicles". The full list of keywords used is included in the appendix of this report.

Of the deals with AI firms, 20 549 were considered as VC investments to fund AI firms and included in this analysis. Deals reported as "Secondary Stock Purchase", "Mergers" or "Add-ons" were excluded from the analysis because these deals do not correspond to financing of start-ups, i.e. the money invested does not go to these start-ups to develop themselves, but to secondary market transactions between one investor and another investor.

The industry categorisation is based on grouping 228 Preqin industry labels into 20 broader categories. The full list of industry categories with the number of deals corresponding to each category is presented in Error! Reference source not found..

Table 1. List of industry categories with number of deals between 2012 and 2020

Industry category	Number of deals
IT infrastructure and hosting	4 063
Media, social platforms, marketing	3 351
Business processes and support services	2 944
Healthcare, drugs and biotechnology	2 545
Robots, sensors, IT hardware	1 532
Financial and insurance services	1 486
Digital security	1 200
Mobility and autonomous vehicles	788
Education and training	564
Logisitics, wholesale and retail	555
Consumer products	503
Travel, leisure and hospitality	219
Agriculture	170
Energy, raw materials and utilities	125
Consumer services	120
Government, security and defence	108
Environmental services	80
Construction and air conditioning	71
Real estate	63
Food and beverages	62
Total number of deals, all industries	20 549

Source: OECD.AI (2021), processed by JSI AI Lab, Slovenia, based on Preqin data of 23/04/2021, www.oecd.ai.

DATA CAVEATS

Many of the reported investment transactions (deals) in the Preqin dataset from 2012 through 2020 do not include the monetary amount of the investment: 18% of the deals for US start-ups and 63% for Chinese start-ups (Table E.1)**.** Where possible, an estimate of missing amounts was calculated based on the median amount of comparable clusters of deals per country of the start-up, investment year and investment stage. When no comparable cluster could be established, no amount was estimated and the amounts were excluded; that is the case for smaller countries which have too few deals and is also the case for certain stages of investments in larger countries such as China where the number of deals with a missing amount is too large compared to the number of deals with a known amount. The impact of estimating amounts for which the amount is missing increases the total value of VC investments by 7% between 2012 and 2020, with an increase of 5% for US-based start-ups and 11% for start-ups based in China over the period (Table E.1)**.**

When considering the origin of the financing, about 16% of deals have no investor identified. This report prorates the value of those deals equally to the deals with reported investors to calculate totals and ignores those deals to calculate averages.

When a single round of financing includes multiple investors, Preqin data does not specify how much each investor has contributed. 20% of deals have investors from two or more

countries. As the Preqin data does not specify how much each investor invested, this report splits the value of these deals equally between investors.

It should be noted that all the data in the report were as of 23 April 2021; as a result, numbers for 2020 and to a lesser extent for previous years can be expected to increase somewhat as more deals are reported, particularly for early stage financing deals, which are sometimes reported only when a later stage of financing occurs.

1. GROWTH OF VC INVESTMENTS IN AI

AI was a growing share of total venture capital investments, reaching 21% in 2020

In 2020, despite the coronavirus pandemic, VC investments continued to grow everywhere, reaching a total of USD 350 billion for the year. AI start-ups attracted 21% of all VC investments in 2020, up from just 3% in 2012 (**Error! Not a valid bookmark self-reference.**), and represented close to USD 75 billion for 2020. Over the past nine years, the share of VC invested in AI increased every year.

Figure 1. Share of total VC invested in AI
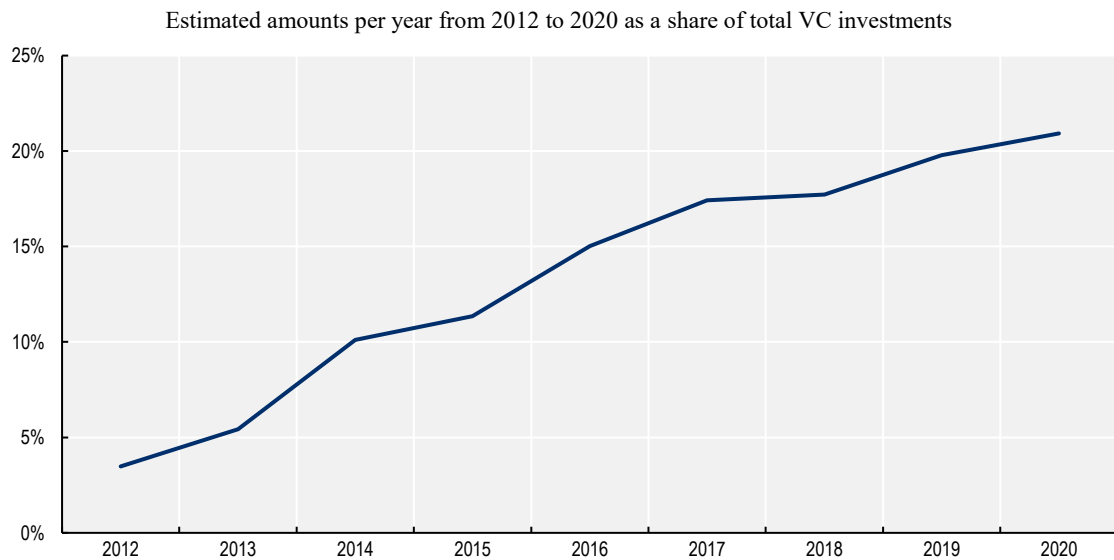
Estimated amounts per year from 2012 to 2020 as a share of total VC investments

Source: OECD.AI (2021), processed by JSI AI Lab, Slovenia, based on Preqin data of 23/04/2021, www.oecd.ai.

The United States and China account for most AI start-up investments

Global annual VC investments in AI start-ups grew from USD 2.6 billion in 2012 to USD 73.6 billion in 2020, representing a 28-fold increase. Over the period from 2012 through 2020, investments in AI start-ups represented cumulative investments of USD 313 billion (Figure 2).

Together, US-based and Chinese start-ups represented over 80% of the monetary value of VC investments in AI start-ups in 2020. This compares to 72% of VC investments the two countries represented across all sectors.

US-based AI start-ups lead both in terms of number of deals (Figure 3) and in dollars invested (Figure 2). They attracted USD 174 billion from 2012 through 2020; over half of the value of VC investments in AI over the period. Their dollar value increased every year.

Figure 2. Estimated VC investments in AI start-ups

By year and country of start-up from 2012 to 2020, in USD billions
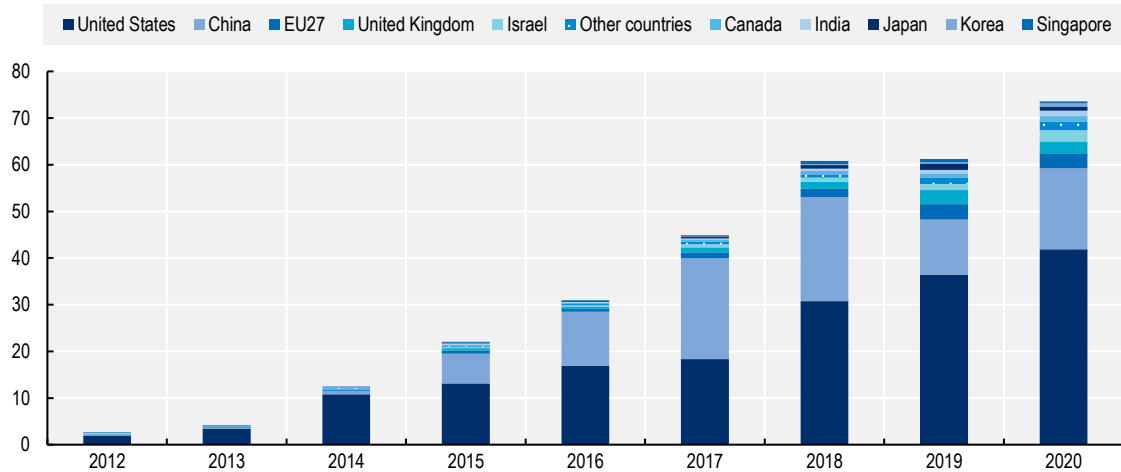
Until 2015, US-based start-ups were the only ones to raise significant amounts of VC investments in AI. Since 2015 China has seen a dramatic upsurge in investment in AI start-ups. From less than 6% in 2014, Chinese companies attracted about 30% of the worldwide value of VC investments in AI start-ups in 2015, 40% in 2016, and 50% in 2017. In 2018, VC investments in Chinese AI firms peaked at USD 22 billion but decreased in relative terms to represent 37% of the worldwide value of VC investments in AI start-ups.

In 2019, VC investments in Chinese AI firms plummeted from USD 22 billion in 2018 to USD 12 billion in 2019. The reasons for the decrease in investments included a broader slowdown of the Chinese economy, trade conflicts between China and the United States and concerns of overheating of China's technology ecosystem (Hanemann et al., 2020[3]).

From 2012 through 2018, around 90% of AI VC was invested in US-based and Chinese start-ups. In 2019 and 2020 the share of AI start-ups based in other countries grew significantly, to reach 20% of investments. In 2019 and 2020, the EU27 represented almost 5% of the value of VC investments in AI start-ups, while UK start-ups collected a little more than 4% of the total value. The EU and the UK were followed by Israel, India, Canada, Japan, Singapore and Korea in terms of amounts invested (Figure 2).

Detailed estimates of yearly VC investments in AI start-ups based in OECD countries are provided in Table A.1.

The number of VC deals in AI firms grew by 34% annually from 2012 to 2019

The number of AI VC transactions grew by 34% per year from 2012 to 2019, from 500 deals in 2012 to more than 3 900 in 2019 (Figure 3). Companies based in the US and China represented about half of the deals in 2020, a share that has been decreasing over the past nine years. Companies based in the EU have seen their share increase over the past nine years and represented more than 11% of deals in 2020.

Figure 3. Number of VC investments in AI start-ups

Number of transactions, by year and country of start-up from 2012-2020
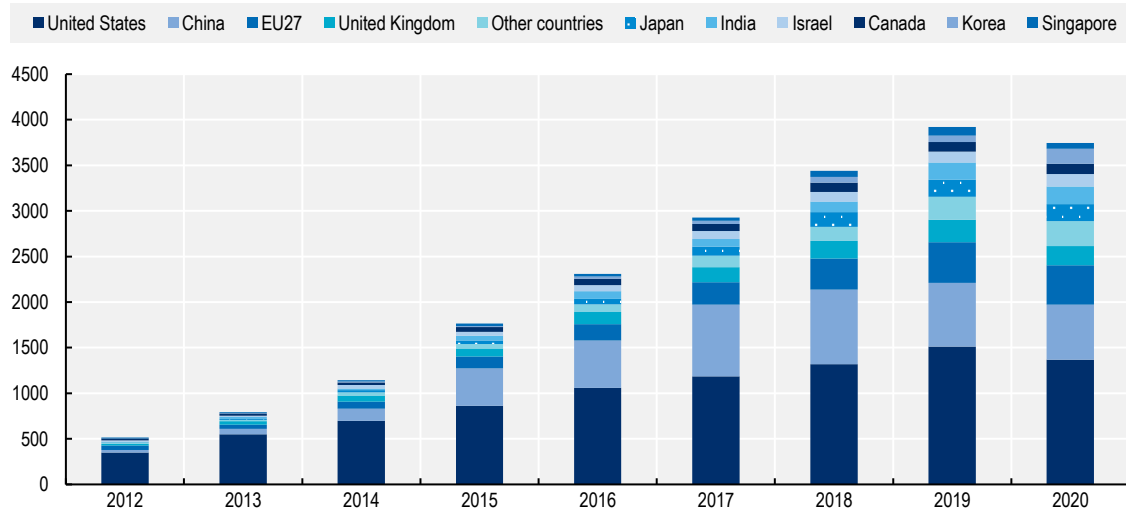
Source: OECD.AI (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 23/04/2021, www.oecd.ai.

The number of deals for 2020 reported by the time of data analysis (late April 2021) was below that of 2019 but could be expected to rise to exceed the total for 2019, as early stage deals tend to be reported with a time lag. Despite the expected growth in number of deals for year 2020, growth in number of deals has been decelerating from +50% per year in the first half of the 2010s, to +30% per annum in 2016 and 2017, to about +15% per annum in 2018 and 2019. This deceleration could reflect maturing technology and investor strategies, with larger amounts focused on fewer AI companies, especially in the United States and China.

Growth in AI investments in China was fuelled by a few very large investments

Between 2015 and 2018, 80% of the total VC investments in Chinese AI firms were very large transactions, worth more than USD 100 million ("mega-deals", **Error! Not a valid bookmark self-reference.**). For example, in 2017, just 27 investments accounted for USD 17 billion raised out of a total for the year of USD 21 billion. The reasons for such large deals included that very large investments were in the mobility and autonomous vehicle industry which is capital-intensive. Another case for this VC activity was the publication of a three-year national AI plan by the Chinese government in May 2016 (OECD, 2019[4]), which planned that China "boost growth of the artificial intelligence (AI) sector in the next three years" (State Council of the People's Republic of China, 2016[5]) and also encouraged broad AI adoption, including both public and private investment. The message was confirmed in the five-year plan of 2016-2021 and mid-2017 by the State Council's Guideline on Next Generation AI Development (State Council of People's Republic of China, 2017[6]). In 2019 and 2020, very large investments in China in AI were less numerous and represented around 60% of the total value of investments, down from 80% in 2018.

Figure 4. Share of AI VC investments worth more than USD 100 million

By year and country of start-up; as a % of total value of AI investments
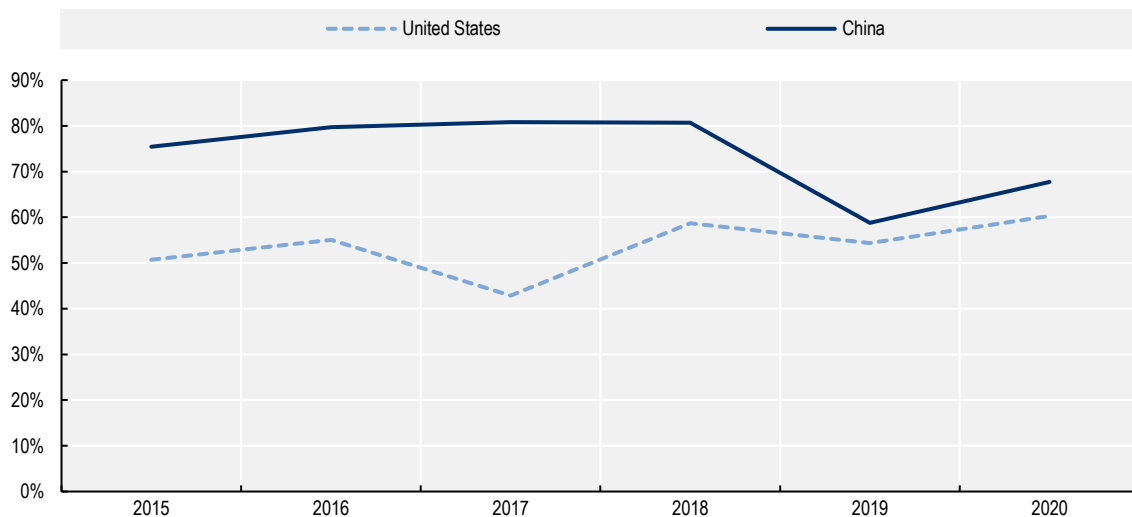
Source: OECD.AI (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 23/04/2021, www.oecd.ai.

In the same time period between 2015 and 2018, VC AI investment in the US was comprised of less very large deals than in China: less than 60% of VC investments in American AI firms were "mega-deals" against 80% of VC investments in Chinese AI firms between 2015 and 2018. As a result, VC AI investment in the US was spread across more AI firms than in China. From 2015 to 2018, Preqin data shows that while total value of AI VC investments in the US were 20% larger than those in China, 50% more American firms benefited from funding (2 150 American AI firms compared to 1 400 Chinese AI firms).

Median investments in AI start-ups are increasingly large as the sector matures

The median amount invested per deal across all countries was USD 5.1 million per investment deal in 2020, more than twice higher than in 2016 (**Error! Not a valid bookmark self-reference.**). In 2020, the median amount invested in start-ups based in China, Israel, the United States and Germany was above the worldwide average. All countries are experiencing growth in the median amount per investment. While Chinese start-ups experienced a dramatic increase from a median of USD 3 million per investment in 2016 to USD 20 million in 2020, American start-ups collected a more gradually growing median investment amount from USD 3.5 million per investment in 2016 to USD 7 million in 2020.

Figure 5. Estimated median amount in AI start-ups per VC investment

By year and country of start-up; 2012-2020; in USD million; logarithmic scale
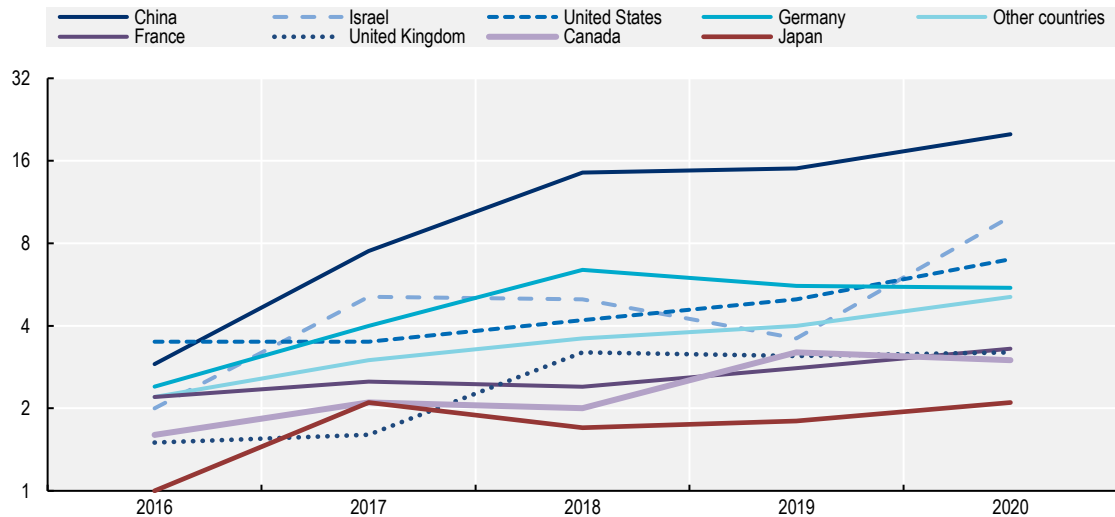
Source: OECD.AI (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 23/04/2021, www.oecd.ai.

The increase in the median amount invested is an indication of a maturing sector: valuations go up as the sector as a whole gave promising signs with some start-ups starting to deliver results; some start-ups need more capital to grow which is why investments are happening at later stages in the lifecycle of start-ups as those companies mature, grow and require more capital to move from research and development (R&D) to production and expand their projects. For example, in the US in 2016, over 50% of the investments were early-stage financing (angel or seed financing); that percentage has decreased since then to represent less than 40% since 2019.

The reason the median amount invested in Chinese start-ups was so much higher than other countries' was partly due to the focus of Chinese AI firms on capital-intensive industries such as "mobility and autonomous vehicles" and "robots, sensors and hardware", which represented two thirds of investments in Chinese firms in 2017, against 30% in American firms.

Another sign of the increasing maturity of the sector is the decrease in the number of start-ups created each year that receive VC funding (Figure 6). The peak years for the establishment of start-ups that went on to raise VC capital was 2016 for the US and the years 2016-2017 for China and the EU 27.

In 2012 and 2013, less than 20% of investments with a reported amount were worth more than USD 10 million (Figure 7). By 2018, more than 30% of investments were for more than USD 10 million. The trend continued through 2020 with almost 40% of reported deals worth over USD 10 million. Similarly, the number of deals worth more than 100 million USD went from only 1 in 2012 to 25 deals in 2015, and to close to 150 in 2020. The trend reflects investors making bigger bets on a smaller number of companies as the AI sector matures.

Figure 6. Number of AI start-ups funded by VC per year of establishment of the start-up

For firms funded between 2012 and 2020; per country and year of establishment of the start-up
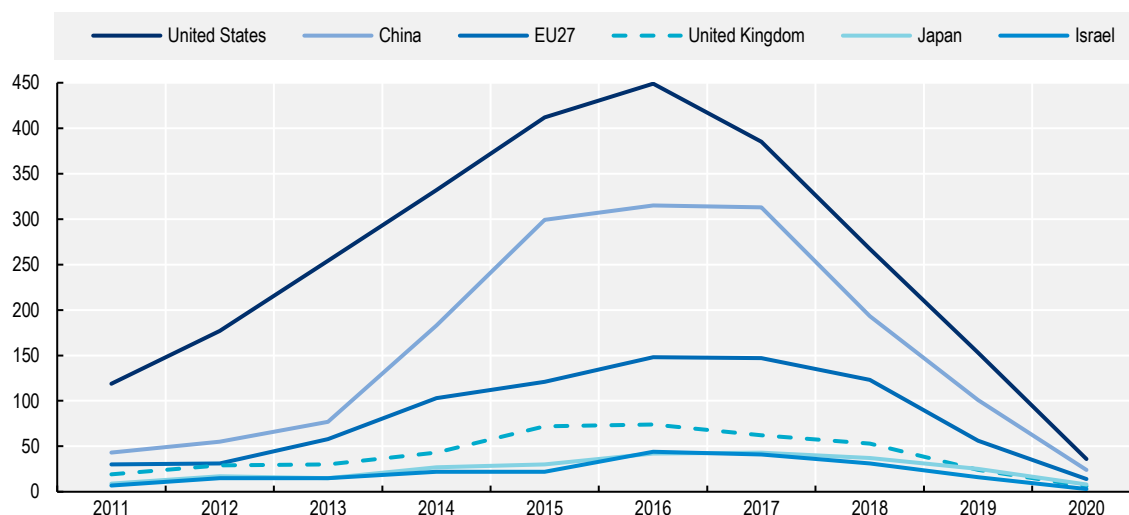
Note: There is a reporting lag such that the trends shown for 2018-2020 are likely to be less pronounced than shown.
Source: OECD.AI (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 23/04/2021, www.oecd.ai.

Figure 7. Number of investments by size

In number of investments by tranche of investment for deals with reported amount
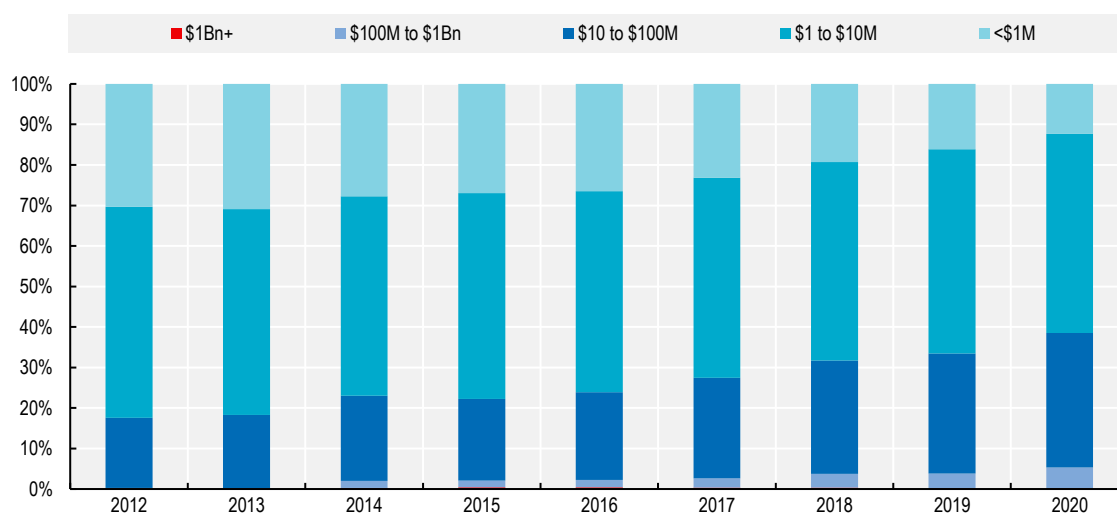
Note: Initial financing by private investors (angel or seed financing) is usually under USD 1 million and is sometimes not reported until further financing occurs, so in coming years the number of reported smaller deals for 2020 and to a lesser extent 2019 may increase.
Source: OECD.AI (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 23/04/2021, www.oecd.ai.

The percentage of VC investments going to AI companies varies significantly depending on the country of the start-up

As mentioned at the beginning of the report (In 2020, despite the coronavirus pandemic, VC investments continued to grow everywhere, reaching a total of USD 350 billion for the year. AI start-ups attracted 21% of all VC investments in 2020, up from just 3% in 2012 (**Error! Not a valid bookmark self-reference.**), and represented close to USD 75 billion for 2020. Over the past nine years, the share of VC invested in AI increased every year.

Figure 1), the share of VC AI investments grew from 3% in 2012 to 21% in 2020. All countries have seen an increase but not in the same proportion: in 2020, 49% of investments in start-ups in Israel were in AI start-ups, compared to 26% in the United States, 19% in China and only 12% in EU27 (Figure 8). While the share of VC investment in AI start-ups in the United States grew steadily from 14% in 2015 to 26% in 2020, China had less regular growth with a strong increase from less than 1% of total VC investments going to AI start-ups in 2012 to a spike of 23% in 2017, then a drop in 2018 to 17%, edging back up to 19% in 2020.

The focus on AI start-ups can also be verified when comparing VC investments to GDP: investments in Israel's AI start-ups represented 0.57% of its 2019 GDP; three times higher than the United States (0.19%) and almost six times higher than China (0.10%).

Figure 8. Share of VC investments going to AI start-ups

% of dollar amounts of investments, per country, from 2012 to 2020
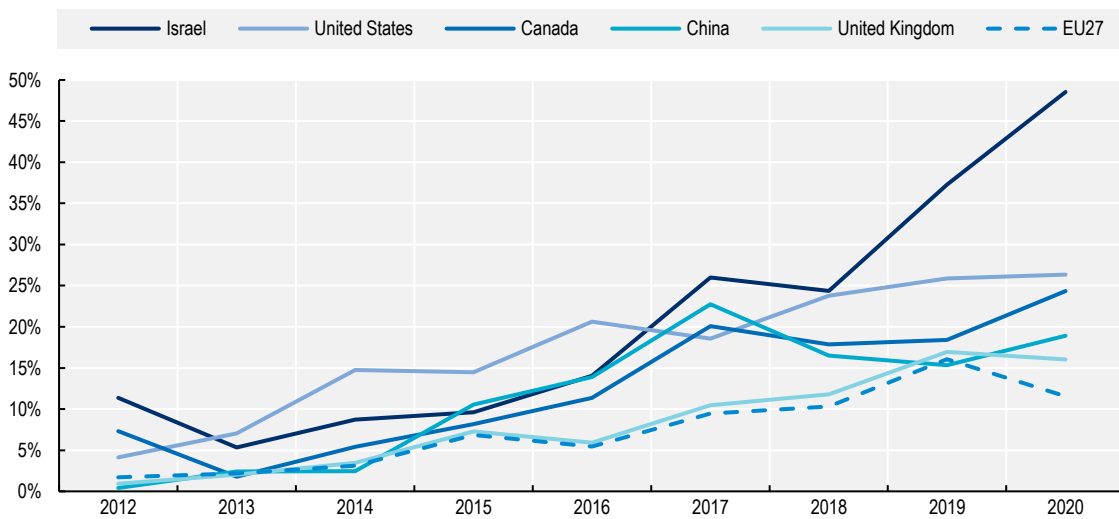
Source: OECD.AI (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 23/04/2021, www.oecd.ai.

2. VC INVESTMENTS BY INDUSTRY

While autonomous vehicles are a key focus of VC investments in AI, many other industries increasingly attract significant investments

Firms in "mobility and autonomous vehicles" captured 29% of the value of VC in AI between 2012 and 2020 (Figure 9), representing USD 92 billion. In 2015 and 2016, the sector attracted about 50% of total VC and represented most of the growth in AI start-up funding. Since 2017, the share of total investments going to "mobility and autonomous vehicles" has decreased, down to a quarter in 2020.

Firms in "media, social platforms and marketing" received 11% of the dollars invested between 2012 and 2020 (USD 34 billion) but only 6% in 2020 (USD 5 billion).

Firms in "healthcare, drugs and biotechnology" received 10% of the dollars invested between 2012 and 2020 (USD 32 billion). Investments in the sector had been increasing gradually from 5% of the total in 2015 (USD 1 billion) to 10% in 2019 (USD 6 billion). In 2020, investments doubled to represent USD 12 billion.

Figure 9. Amount of VC investments in AI start-ups per industry

Estimated amounts from 2012 to 2020, in USD billions
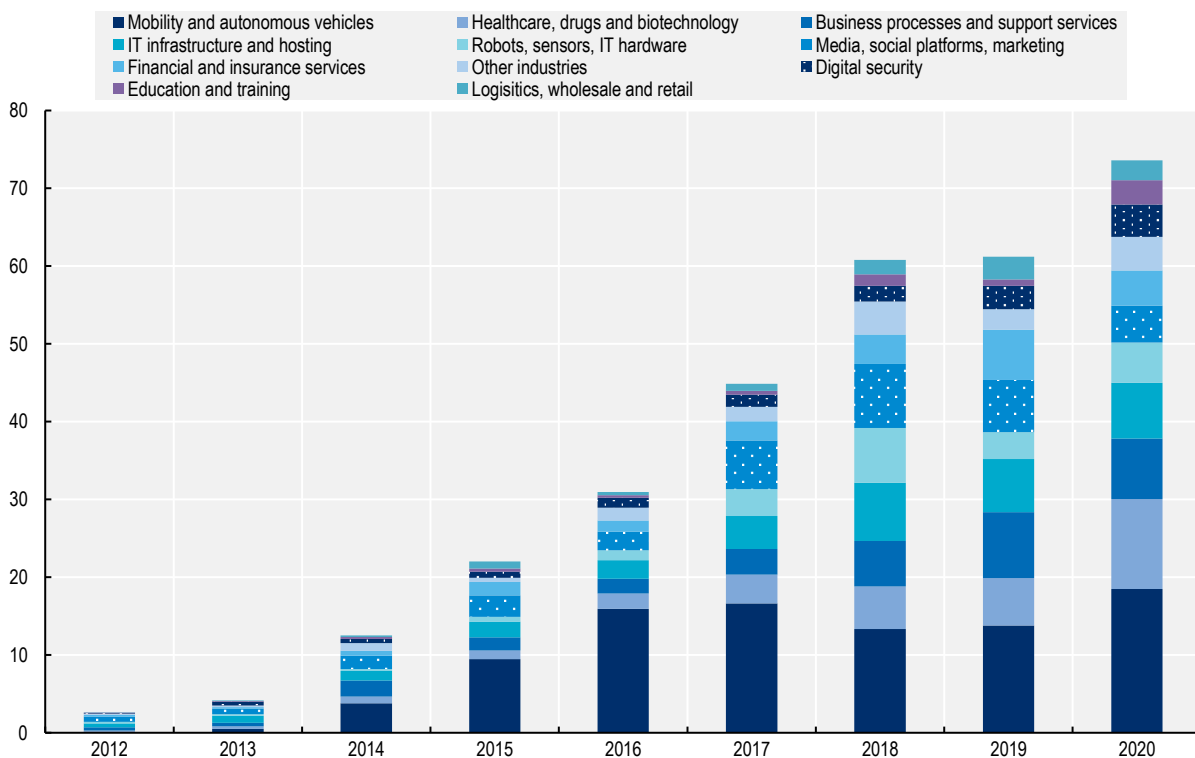
Source: OECD.AI (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 23/04/2021, www.oecd.ai.

Firms in "IT infrastructure and hosting" attracted more than 10% of total VC in 2020 (USD 8 billion), a share that has been relatively stable since 2012.

Other industries having attracted most VC in 2020 included:

- "business processes and support services", for USD 8 billion (close to 11% of total VC);

- "financial and insurance services", for USD 5 billion (7%);

- "robots, sensors and IT hardware, for USD 5 billion (7%);

- "digital security", for USD 4 billion (5%).

Except for mobility and autonomous vehicles – a priority in both the US and China – VC investments in US, Chinese and EU27 AI firms targeted different sectors

Investments in AI start-ups based in the US were distributed over a broad range of industries (Figure B.1), the top 5 of which were: mobility and autonomous vehicles (30% between 2012 and 2020); healthcare (13%); business processes and support services (11%); IT infrastructure and hosting (10%); media, social platforms and marketing (8%); and financial and insurance services (7%).

Investments in Chinese AI start-ups (Figure C.1) were more focused, and were led by mobility and autonomous vehicles (41% of VC investments from 2012 to 2020); media, social platforms and marketing (14%); robots, sensors and IT hardware (13%); IT infrastructure & hosting (8%); and business processes and support services (7%).

In the EU27, the top 5 industries between 2012 and 2020 were: media, social platforms and marketing (20%); business processes and support services (19%); financial and insurance services (16%); IT infrastructure and hosting (13%); and, healthcare, drugs and biotechnology (12%).

Detailed estimates of VC investments in AI start-ups based in OECD countries by industry are provided in Table A.2.

VC invested in "mobility and autonomous vehicles" went mostly to AI firms based in China until 2017 and, from 2018, mostly to firms based in the US

The mobility and autonomous vehicles industry attracted USD 4 billion in 2014, representing 30% of the total VC investments in AI start-ups, USD 9 billion in 2015, USD 16 billion in 2016, and USD 18 billion in 2017. In 2018, VC went down USD 13 billion with the slump in investments in Chinese mobility start-ups despite a spike in VC invested in American firms. In 2020, investments in the industry grew again significantly, both in American and in Chinese firms, to reach USD 19 billion (Figure 10).

Figure 10. Amount of VC investments in AI mobility and autonomous vehicles start-ups

Per country and per year from 2012 to 2020, in USD billions
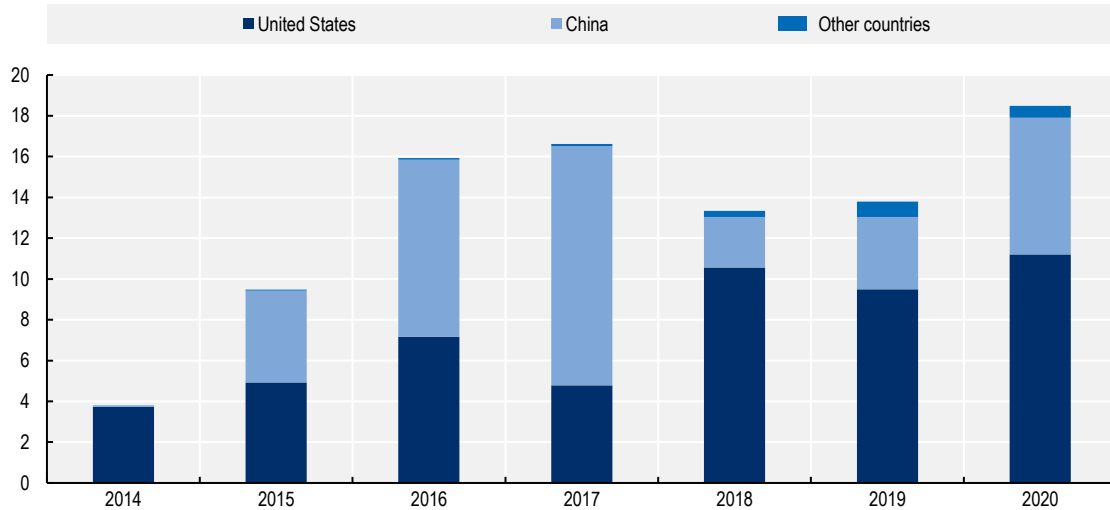
Source: OECD.AI (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 23/04/2021, www.oecd.ai.

The mobility and autonomous vehicles industry includes autonomous navigation systems, driverless vehicles on ground, in water, in the air and in space, and car-hailing, hiring and sharing services. Amounts invested in the industry were extremely high for several reasons. On the one hand the largest investee start-ups, the car-hailing leader in China, Didi Chuxing (**Table 2.1**), and those in the US and the rest of the world, Uber and Lyft, had to raise capital to compensate for billions in losses and investments until Uber and Lyft went public in 2019 to fund themselves and Didi turned its first profit in 2020 (Templeton, 2021[7]). At the same time, the industry requires large capital expenditures because it cuts across many AI technologies (computer vision, machine learning, natural language processing, etc.), includes many components and sensors, requires high reliability given risks and liability involving accidents, and necessitates production facilities that are capital-intensive (WIPO, 2019[8]).

More than any other industry, the "mobility and autonomous vehicles" industry has been dominated by AI start-ups based in the US and in China. Together they have raised USD 92 billion over the past nine years, representing 98% of the total. Over the nine-year period, Chinese start-ups attracted 41%, against 57% for American start-ups; especially over the period 2018 to 2020, American start-ups raised almost three times as much VC as Chinese start-ups did.

In the meantime, leading European and Japanese car makers, such as Toyota, Volkswagen and BMW, and original equipment manufacturers, such as Bosch, Faurecia and Denso, are mostly investing in-house to develop their own capabilities and also purchasing solutions from American start-ups (WIPO, 2019[8]). An example of an American start-up providing "self-driving" technologies to traditional car makers is Waymo (Waymo, 2021[9]), which was originally started in 2009 as Google's self-driving car project and is a supplier for Toyota, Daimler Trucks, Fiat-Chrysler and the Renault-Nissan-Mitsubishi Alliance.

Table 2.1. Top mobility and autonomous vehicles companies by amount of VC raised

Estimated amounts of VC raised from 2012 to 2020, in USD billions

Company name	Country	Description	VC raised 2012-2020
Didi Chuxing	China	Didi Chuxing was founded in 2012. It is the leading car-hailing service in China. Its investors include Tencent, Alibaba and Apple. It has invested in autonomous vehicles and relies on AI for providing its service.	22
Uber Technologies	US	Founded in 2009, Uber operates a ride-hailing service. It went public in 2019. It invested in autonomous vehicles until selling its unit in 2021 to Aurora. Per its SEC filings, it relies heavily on AI for its operations.	18
Lyft	US	Founded in 2007, Lyft (f.k.a Zimride) operates ride-hailing service. It has invested in autonomous vehicles. It went public in 2019.	7
Rivian	US	Founded in 2009, Rivian manufactures autonomous electric vehicles,the first of which were launched in 2018.	5
Nio Limited	China	Founded in 2014, Nio manufactures autonomous electric vehicles. It also offers NOMI, an in-vehicle AI digital assistant.	5
Cruise	US	Founded in 2013, Cruise is backed by Microsoft and produces an autopilot system using artificial intelligence for self-driving electric cars.	4
Argo AI	US	Founded in 2017, Argo AI is backed by Ford and develops self-driving technologies for autonomous driving vehicles.	4
Xpeng	China	Founded in 2014, Guangzhou Xiaopeng Motors Technology, also known as Xpeng, manufactures autonomous electric automobiles. It also offers car renting services.	3
Waymo	US	Founded in 2009, Waymo is backed by Google and develops self-driving technologies and manufactures self-driving cars.	3
WM Motors	China	Founded in 2015, Weimar New Energy Vehicle Sales or WM Motor manufactures electric autonomous vehicles.	3
Nuro	US	Founded in 2016, Nuro manufactures AI-based autonomous vehicles, enabling enterprises to transport various goods to consumers (ex.Domino's pizza in Houston, TX).	2
Pony.ai	US	Founded in 2016, Pony.ai proposes autonomous driving technology to facilitate the manufacturing of automated vehicles.	1

Source: OECD.AI (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 23/04/2021, www.oecd.ai

More than one quarter of VC investments in "media, social platforms and marketing" went to ByteDance, the rest to many smaller firms

This report groups media, social platforms and marketing due to convergence of different media that rely on marketing and advertising, including social media, as well as blurring boundaries between professional and non-professional content creation (OECD, 2019[10]). Facebook and Google illustrate models in which amateur and professional users create content that is shared via social networks and leveraged for advertising and marketing.

From 2012 through 2020, media, social platforms and marketing start-ups attracted USD 34 billion, 11% of the total VC investment in AI firms. 2018 was a peak year for the industry, it attracted USD 8 billion in VC funding, half of which were invested in ByteDance, the Chinese start-up that owns TikTok. Table 2.2 includes a selection of AI firms in that space that raised more than USD 100 million between 2012 and 2020.

Table 2.2. Selected AI media, social platforms and marketing companies that raised significant equity between 2012 and 2020

Company name (country)	Estimated capital raised	Description
ByteDance (China)	USD 9 billion (2012 to 2020)	Operates content platforms TikTok (user-made video sharing) and Toutiao (a personalised news and content platform).
Dataminr (US)	USD 600 million (2012 to 2018)	Helps businesses analyse social media sources to trigger real-time information alerts to clients
Trax Technology Solutions (Singapore)	USD 400 million (2013 to 2019)	Provides market data services for retailers by using image recognition and deep learning to analyse data and images captured by mobile devices, fixed cameras and robots.
Coveo (Canada)	USD 300 million (2012 to 2019)	Provides information access and search solutions, including via character recognition in scanned documents.
Meero (France)	USD 300 million (2017 to 2019)	Operates an intermediary platform between photographers and businesses that enhances photos for food, real-estate, e-commerce, etc.
Adjust (Germany)	USD 260 million (2012 to 2019)	Provides automated marketing analytics solutions that help businesses to track, monitor, and measure campaigns.
Blippar (UK)	USD 137 million (2012 to 2018)	Provides an artificial intelligence-powered platform for creating and inserting augmented reality-based images.

Note: There were an additional five investments in ByteDance included in the Preqin database over the period without a disclosed amount; those investments were not estimated.
Source: OECD.AI (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 23/04/2021, www.oecd.ai.

Investments in "healthcare, drugs and biotechnology" doubled in 2020 and accounted for 16% of total AI investments

The "healthcare, drugs and biotechnology" industry experienced exceptional growth in 2020 (Figure 11) due to the pandemic that brought the spotlight on the potential for AI to accelerate research in new drugs, enable more efficient and reliable diagnosis, and automate front-end processes (e.g. providing information to patients) and back-office tasks (e.g. inventory management). Total VC in AI healthcare doubled from USD 6 billion in 2019 to USD 12 billion in 2020.

Figure 11. VC investments in AI start-ups in healthcare, drugs and biotechnology

Per country and year from 2012 to 2020, in USD billions

Source: OECD.AI (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 23/04/2021, www.oecd.ai.

Thirty-three AI healthcare companies raised more than USD 100 million in 2020 alone, of which twenty-four were American, five Chinese, one Canadian, one German, one Israeli and one Swiss. Four of these companies raised more than USD 300 million in 2020:

- Tempus Labs (US) raised USD 550 million in 2020 for its AI-assisted decision-making solutions for treatment of cancer and other diseases. Its genomic and transcriptomic sequencing services analyse somatic data, germline molecular data, and therapeutic data, assisting physicians in making data-driven decisions for treatment;

- GRAIL (US) raised USD 390 million for its blood screening tests using data sequencing on the genomic and molecular biology of tumours for the early detection of cancer;

- Olive AI (US) raised USD 383 million for AI-assisted workflows for the healthcare industry;

- XtalPi (US) raised USD 319 million to help pharmaceutical and biotech companies increase the efficiency and accuracy of the drug discovery process.

3. INVESTORS IN AI VC

VC investors from the US were the most active in AI globally and represented 41% of total investments in 2020

The American VC industry is the most mature, has the most capital to invest and has the most experienced professionals to attract, screen, negotiate and manage investments, particularly in new technologies (OECD, 2015[11]). American VC investors were the first to invest in the AI space and have increased their investments in AI firms every year from USD 2 billion in 2012 to USD 32 billion in 2020 (Figure 12). In 2020, investments by American VC investors represented 43% of total investments, twice those of Chinese VC investors (USD 15 billion), and four times those of EU27 investors (USD 7 billion).

Figure 12. Investments in AI start-ups by country of the VC investors

Stacked per country and year from 2012 to 2020, in USD billions
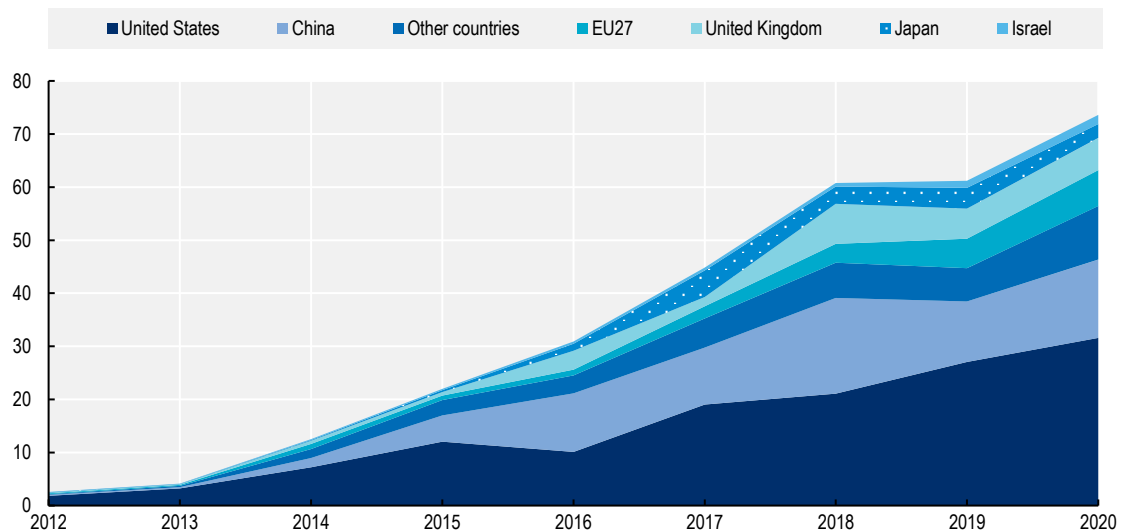
Note: 20% of deals have investors from two or more countries, As the Preqin data does not specify how much each investor invested, the present report splits the value of these deals equally between investors. 15% of deals have no investors specified; the present report prorates the value of those deals equally to the deals with reported investors.
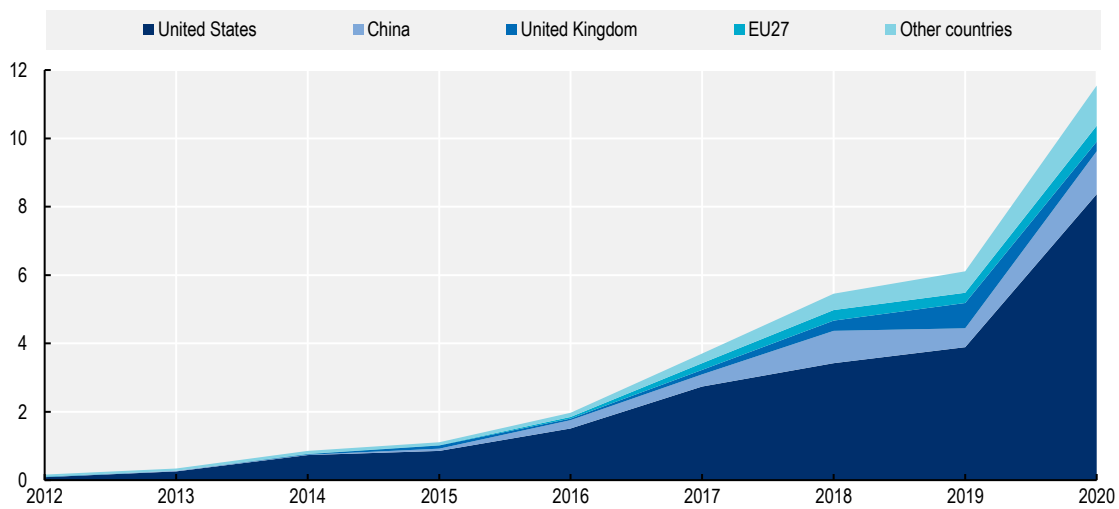*Source*: OECD.AI (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 23/04/2021, www.oecd.ai.

VC investors from the EU27 were increasing their investments in AI start-ups

EU 27 investors continuously increased their investments in AI start-ups from insignificant levels until 2014 to almost USD 7 billion in 2020 (Figure D.1). EU27 have also been involved in increasing numbers of deals, participating in over 800 deals in 2020, over the number involving Chinese investors, only second to US VC investors who participated in 1 700 deals.

There were significant differences in the sector focuses of EU27 as a whole, Germany and France (Figure D.3, Figure D.4 and Figure D.5, respectively).

US and China seem to be net beneficiaries of VC funding in AI firms

The two leading countries in terms of AI start-ups, China and the US, were net beneficiaries of VC investments over the period 2012-2020. US AI firms received USD more than 173 billion in VC while US investors invested USD 133 billion, a difference of USD 40 billion (23% of VC raised). Chinese AI firms received USD 92 billion in VC while Chinese investors invested USD 73 billion, a difference of USD 19 billion (19% of VC raised over the same period) (**Error! Not a valid bookmark self-reference.**).

Figure 13. Net investments in AI start-ups by country

Total VC raised minus total VC invested from 2012 to 2020, in USD billions
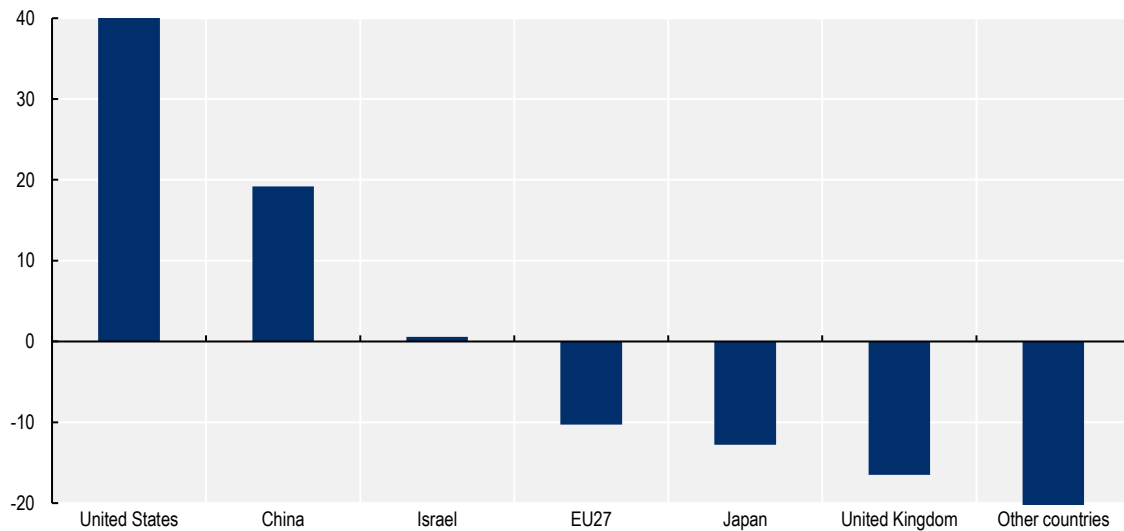
Source: OECD.AI (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 23/04/2021, www.oecd.ai.

Investors from countries other than the US and China, including the EU27, contributed to financing AI investments in American and Chinese start-ups. Over the period from 2012 to 2020, VC investors from countries other than the US and China invested USD 59 billion in Chinese and American AI firms.

Both US and Chinese investors are the main investors in their national AI firms, with Chinese VC investors holding a larger share of their own market

American and Chinese VC investors were both the leading investors in their respective national markets: American investors accounted for about 60% of VC invested in AI firms based in the US in 2019 and 2020; Chinese VC investors accounted for about 70% of VC invested in Chinese AI firms in 2019 and 2020, ten percentage points more (**Error! Not a valid bookmark self-reference.**).

Figure 14. Share of American (US) and Chinese VC investors in their respective national markets

% of total USD investments, per country of investor, per country of start-up and per year
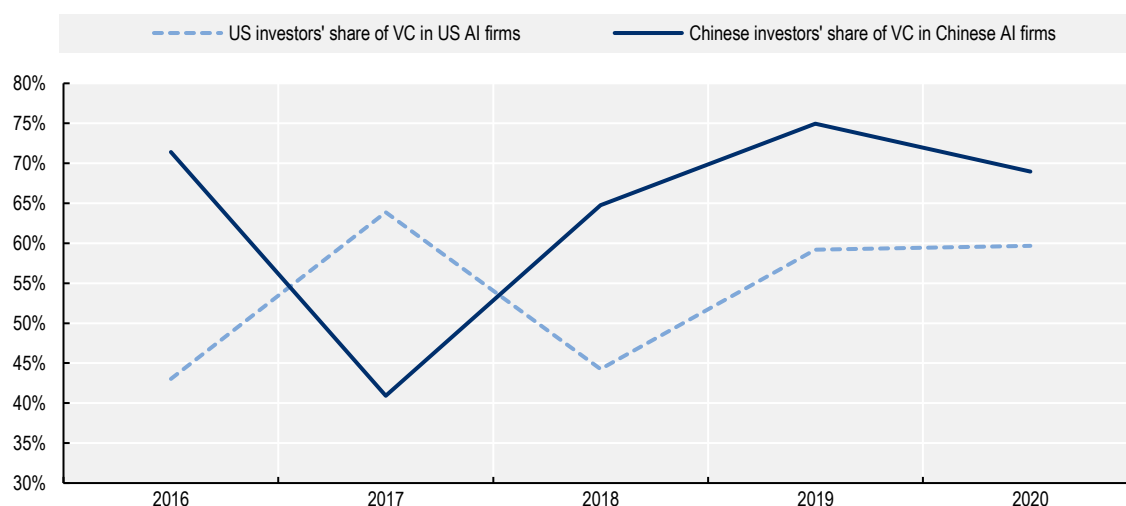
Source: OECD.AI (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 23/04/2021, www.oecd.ai.

Chinese VC investors represented about two thirds of investments in Chinese AI firms over the period from 2016 to 2020, except in 2017 where they represented about 40%. As noted earlier, in 2017, the value of investments in Chinese AI start-ups doubled and the number of transactions increased by 50% from about 500 in 2016 to about 800 in 2017. The uptick in financing of China-based AI firms in 2017, and partly in 2018, was largely funded by foreign investors, especially American and Japanese investors. The reliance on foreign capital in 2017 was due to the sudden increase in capital needed; in 2018 the share of foreign VC started to decrease.

Reasons for the decrease of foreign VC investment in Chinese AI firms included tightening regulation in China and perceived risks for non-local investors from increased political confrontation between China and major developed economies. In parallel, the Chinese VC industry gained in maturity with three kinds of local actors taking over: "home-grown rivals, a few thousand government-funded incubators (…), and China's internet giants, with their (…) appetite for deal making" (The Economist, 2020[12]):

- **Chinese VC investors**: many of the current largest VC investors in China were originally partnerships spun off from large foreign VC firms. Some examples include Sequoia Capital China (from Sequoia, US), KPCB China / TDF Capital (from Kleiner Perkins, US), Matrix Partners China (from Matrix Partners, US) and Softbank China Venture Capital (SBCVC, from Softbank, Japan).

- **Chinese government-funded incubators**: The number of local and national government guidance funds grew from 2015 onwards (Luong, Arnold and Murphy, 2021[13]). An example of the guidance funds that invested significantly in Chinese AI is the China Structural Reform Fund, launched in 2016 with USD 20 billion and that funded Weimar, an autonomous vehicle firm, among others. China Structural Reform Fund II to start investing in 2021, having raised USD 12 billion, based on Preqin data.

- **Large Chinese technology firms**: These large technology firms, also known as BATJ (Baidu, Alibaba, Tencent, JD.com), have become major actors in Chinese VC investments. One of those giants is Alibaba; Preqin's database shows that Alibaba was part of at least 33 investment deals worth more than USD 22 billion in Chinese AI start-ups between 2015 and 2020.

American VC represented more than a fifth of VC funding of non-Chinese and non-American AI firms in the world, while Chinese investors represented less than 5%

Since 2017, American investors have represented between 20% and 24% of VC investments in AI firms outside China and the US (**Error! Not a valid bookmark self-reference.**). Over the same time period, Chinese investors represented 5% or less of VC investments in AI firms outside China and the US. The Chinese VCs seem to focus on developments in China whereas the American VC industry has global reach.

Figure 15. Share of US and Chinese VC investors in foreign markets

% of total USD investments, per country of investor, per country of start-up and per year
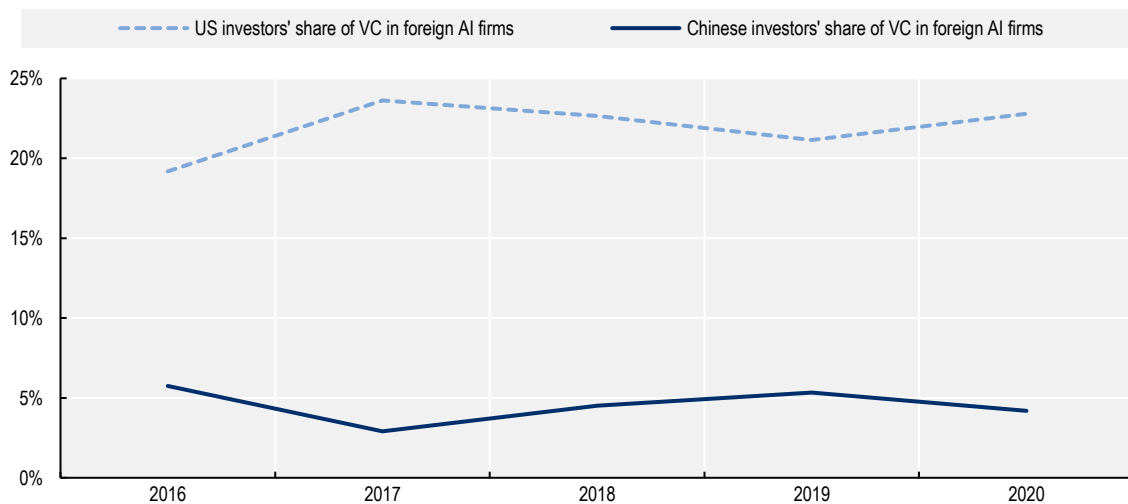
Source: OECD.AI (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 23/04/2021, www.oecd.ai.

US investors' share of the VC funding of Chinese AI firms has been decreasing, as has Chinese investors' share of the VC funding of AI firms based in the US

American investors represented 10% of VC investment in Chinese AI firms in 2019 and 2020, down from 25% in 2017 (**Error! Not a valid bookmark self-reference.**). As noted previously, 2017 was an exceptional year because of the sudden increase in capital needed to fund Chinese AI firms.

Figure 16. Share of US and Chinese VC investors in each other's national markets

% of total USD investments, per country of investor, per country of start-up and per year
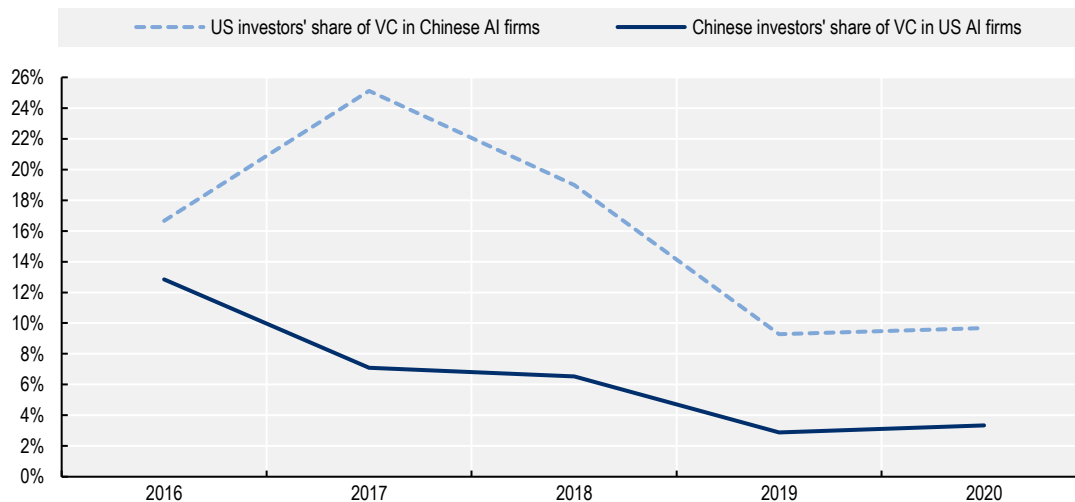
Source: OECD.AI (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 23/04/2021, www.oecd.ai.

In parallel, the share of Chinese VC in the US plunged from representing 14% in 2016 to 3% in 2019 and 2020. The trend was accelerated by the growing concerns expressed by American politicians, which translated in the voting of new limitations in foreign investments in American technological firms with the 2018 Foreign Investment Risk Review Modernization Act (FIRRMA) and the Export Control Reform Act (ECRA) (Gump, 2018[14]). Both acts increased scrutiny over investments from foreign investors in "emerging" and "foundational" technologies which can be deemed "essential to the national security of the United States."

Annex A. Detailed data for OECD countries

Table A.1. **Estimated VC investments in AI start-ups based in OECD countries, by year**

By year and country of start-up from 2012 to 2020, in USD millions

	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
United States	1 868	3 462	10 799	13 096	16 930	18 346	30 768	36 375	41 870	173 513
United Kingdom	38	55	140	497	492	1 174	1 567	3 076	2 529	9 567
Israel	102	65	147	186	272	684	857	1 247	2 365	5 926
Germany	29	40	80	386	180	375	655	1 581	1 350	4 675
Canada	107	31	117	218	312	592	729	914	1 204	4 224
Japan	5	27	85	152	224	428	738	1 376	909	3 944
France	19	16	26	68	143	301	492	809	710	2 585
Korea		2	23	14	34	58	257	260	628	1 275
Australia	5	10	35	20	59	85	271	384	235	1 103
Switzerland	19	19	32	43	47	116	129	261	345	1 011
Spain	5	7	27	33	70	76	95	205	231	748
Sweden	1	13	3	9	36	85	110	93	193	544
Belgium	1			23	18	56	66	123	138	425
Ireland	2	1	6	6	21	69	86	63	115	368
Netherlands	1	12	6	34	24	55	62	66	79	338
Finland	8	22	12	34	17	51	33	70	80	328
Norway					5	14	20	133	142	314
Denmark	2	1	6	27	35	19	21	76	82	270
Austria		2	6	35	28	11	28	47	82	238
Italy	1	3	2	3	6	12	32	16	67	140
Iceland				98		1		2	33	134
Chile				0	0	0	4	35	91	131
Mexico			1	3	7	22	1	30	37	101
Poland	0	0	8	0	7	23	1	20	40	100
Hungary			1	3	8	1	45	11	23	92
New Zealand	2		3	5	8	2	17	5	39	81
Czech Republic	6		26		1	1	1	3	11	49
Slovak Republic					1	11		31		42
Portugal					2		6	21	8	37
Luxembourg	0	4		0	0	6	2	-	8	20
Turkey			1	4	5	2	0	8	1	20
Estonia					0	0	4	3	9	16
Colombia					6		2	7	0	15
Lithuania					1	0	2	6	3	12
Slovenia	-				1	-		0	6	7
Greece							-		3	3
Costa Rica					0	1				1
Latvia									0	0
Total	**2 221**	**3 793**	**11 592**	**14 995**	**19 000**	**22 677**	**37 100**	**47 358**	**53 667**	**212 403**

Source: OECD (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 23/04/2021, www.oecd.ai.

Table A.2. Estimated VC investments in AI start-ups based in OECD countries by industry

Total investments from 2012 to 2020 by industry and country of start-up, in USD millions

	Mobility and autonomous vehicles	Healthcare, drugs and biotechnology	Business processes and support services	IT infrastructure and hosting	Media, social platforms, marketing	Financial and insurance services	Digital security	Robots, sensors, IT hardware	Logistics, wholesale and retail	Consumer products	Construction and air conditioning	Education and training	Other activities	Total
United States	52 423	21 866	19 510	18 029	13 027	12 076	10 534	5 880	6 627	5 081	2 193	1 643	4 624	173 513
United Kingdom	163	1 599	1 611	1 259	1 275	1 960	650	788	101	43	7	54	58	9 567
Israel	217	906	302	1 129	517	120	925	1 294	151	22	40	..	304	5 926
Germany	122	505	718	455	746	1 276	167	187	30	5	14	63	386	4 675
Canada	30	709	364	796	745	405	56	451	108	39		25	495	4 224
Japan	814	272	509	653	577	497	60	234	40	58	20	100	110	3 944
France	94	402	196	451	673	265	93	56	166	81	65	18	25	2 585
Korea	80	188	39	517	106	70	17	102		9		117	33	1 275
Australia	52	115	227	204	212	130	11	21	10				122	1 103
Switzerland	20	344	113	220	51	40	45	62	59	23	1		33	1 011
Spain	15	71	370	53	84	67	30	17		1		2	38	748
Sweden		74	58	108	125	55	9	4	56	36		13	6	544
Belgium	1	21	351	29	4	11	1	1		1			4	425
Ireland		116	64	98	39	10	16		13	9			4	368
Netherlands	1	43	69	58	124	7	24	3				3	6	338
Finland	7	41	152	34	24		1	43		3			23	328
Norway			89	115	44	1		29			1	2	33	314
Denmark		11	5	20	125	51	40	4		8			5	270
Austria		46	72	39	52							19	9	238
Italy	7	8	37	7	74	4	1			1			1	140
Iceland					125		8					1		134
Chile			1	6					4				120	131
Mexico		1	2	15	10	6			66			0		101
Poland	1	20	10	10	16	36		9						100
Hungary		4	4	13	2		1	67						92
New Zealand					53	26				3				81
Czech Republic			4	9	34		3							49
Slovak Republic				3	39									42
Portugal		1	4	7	14	1	1	9		1				37
Luxembourg				2	15	3								20
Turkey		1	4		8		0		3				4	20
Estonia				11	1	2							2	16
Colombia			1		6		5						4	15
Lithuania	0	2			7	2							1	12
Slovenia			6		2									7
Greece				3										3
Costa Rica													1	1
Latvia		0		0										0
Total	**54 044**	**27 367**	**24 892**	**24 532**	**18 804**	**17 102**	**12 691**	**9 261**	**7 437**	**5 422**	**2 341**	**2 059**	**6 452**	**212 403**

Source: OECD (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 23/04/2021, www.oecd.ai..

Annex B. Industry focus in the United States

Over the period from 2012 to 2020, mobility and autonomous vehicles attracted 30% of total investments in AI firms based in the US (**Error! Not a valid bookmark self-reference.**Figure B.1). In 2019 and 2020, this share decreased to represent slightly more than a quarter of VC in AI. American start-ups that raised large amounts of VC included Argo AI, Uber, Rivian Automotive, Waymo, Cruise and Nuro (Table 2.1).

Figure B.1. Top industries in terms of VC investments for US start-ups
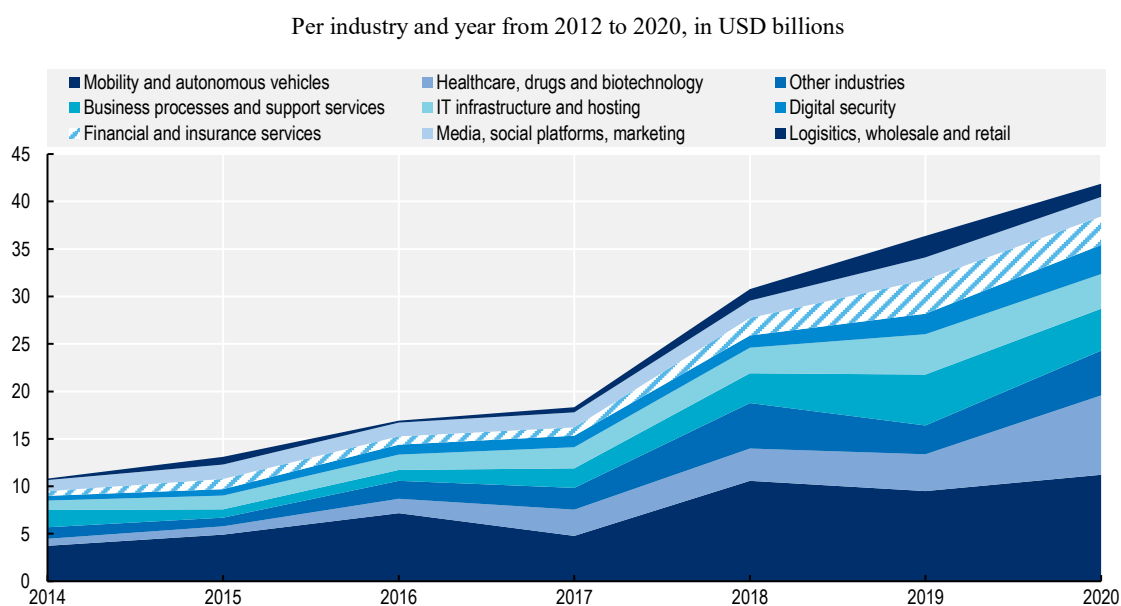
Per industry and year from 2012 to 2020, in USD billions

Source: OECD.AI (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 23/04/2021, www.oecd.ai.

Healthcare represented 13% of investments over the period and 20% in 2020 (USD 8.5 billion). With the spotlight on healthcare during the pandemic, twenty-five American companies attracted investments of over USD 100 million each in 2020 alone, including those mentioned previously: Tempus Labs, GRAIL, Olive AI and XtalPi.

Start-ups that focused on automating business processes and improving support services attracted 11% of total investments over the period. Selected US start-ups that attracted significant funding in 2020:

- TripActions (close to USD 700 million), which automates business processes related to corporate travelling;

- DataRobot (more than USD 300 million) which operates a platform for using AI to identify potential for improvements in enterprises' business functions;

- UiPath (more than USD 200 million) which adds a layer of AI to robotic process automation solutions to automate cognitive processes, using computer vision, natural language processing and machine learning of unstructured data;

- Gong.io (USD 200 million), which operates a conversion intelligence platform that uses artificial intelligence to record, transcribe and analyse sales conversion.

Other industries that attracted significant investments in the US included IT infrastructure and hosting (10% of investments from 2012 to 2020); media, social platforms and marketing (8%); financial and insurance services (7%); digital security (6%); logistics, wholesale and retail (4%).

Annex C. Industry focus in China

Over the period going from 2012 to 2020, 41% of investments going to Chinese AI start-ups went to mobility and autonomous vehicles companies (Figure C.1), including 39% in 2020. Leading Chinese AI start-ups in raising capital included Didi Chuxing, Xpeng, Nio and WM Motors (Table 2.1).

Figure C.1. Top industries in terms of VC investments for start-ups based in China

Per industry and year from 2012 to 2020, in USD billions
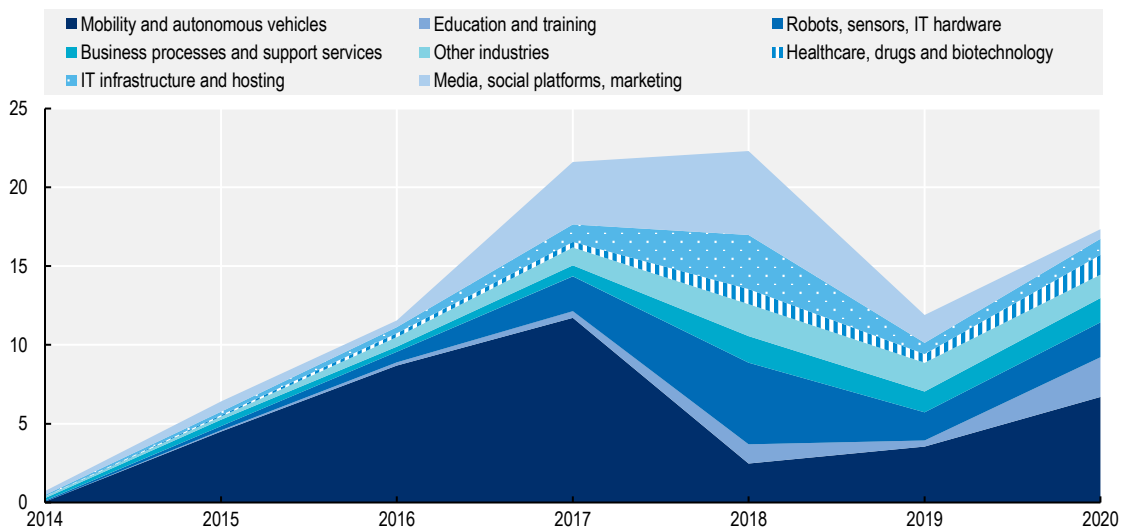
Source: OECD.AI (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 23/04/2021, www.oecd.ai.

Over the same period, Chinese AI start-ups in robots, sensors and IT hardware attracted 13% of all investments. Leading AI start-ups in terms of capital raised included:

- Horizon Robotics that provides computer vision capabilities and raised close to USD 2 billion since 2015;

- Bitmain Technologies that produces semiconductors for blockchain and artificial intelligence and raised USD 1.8 billion since 2013;

- UBTECH Robotics that produces AI-powered robots, including consumer humanoid robots and robots for business use, such as a recent one for disinfecting offices from COVID with UV light, and raised USD 1.3 billion since 2013.

Other industries having raised large VC investments in China from 2012 to 2020 included:

- "media, social platforms and marketing" for USD 13 billion, 70% of which was for financing previously mentioned ByteDance,

- "IT infrastructure & hosting" for USD 7 billion,

- "business processes and support services" for USD 6 billion, and

- "education and training" for USD 5 billion.

Annex D. Additional information on EU27

Figure D.1. Investments in AI start-ups by country of the EU27 VC investors

Stacked per country and year from 2012 to 2020, in USD billions
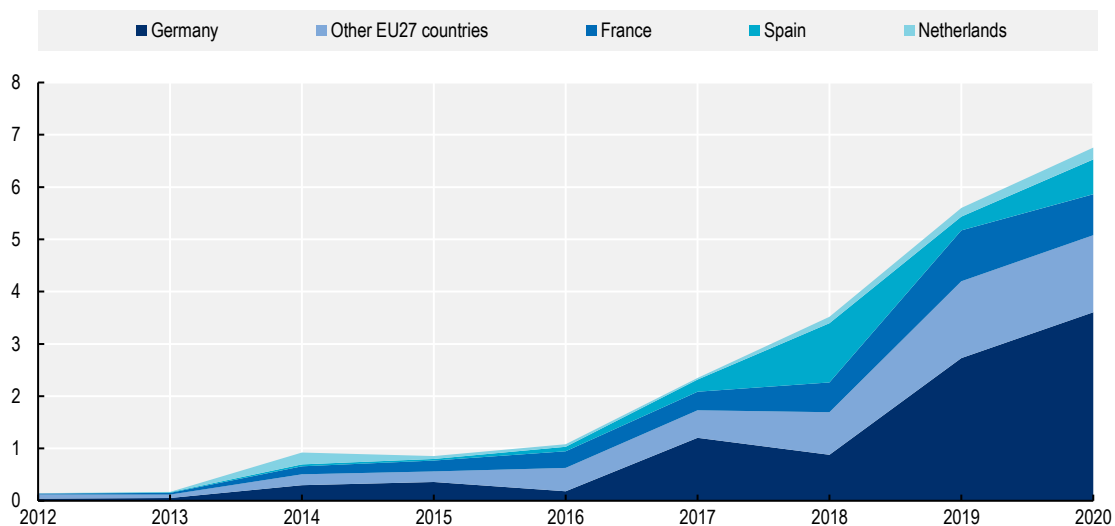
Source: OECD.AI (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 23/04/2021, www.oecd.ai.

Figure D.2. Net investments in AI start-ups by EU27 country of investor

Total VC raised minus total VC invested; from 2012 to 2020, in USD billions
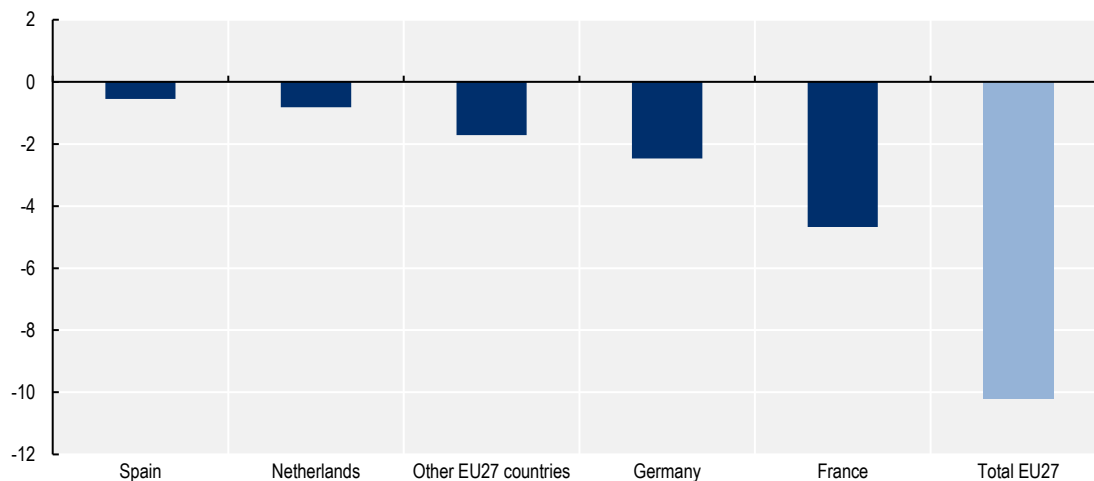
Source: OECD.AI (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 23/04/2021, www.oecd.ai.

Figure D.3. Investment flow of EU27 VC investors in 2020

Flow of EU27 VC in value to what industry and to what country of AI firm
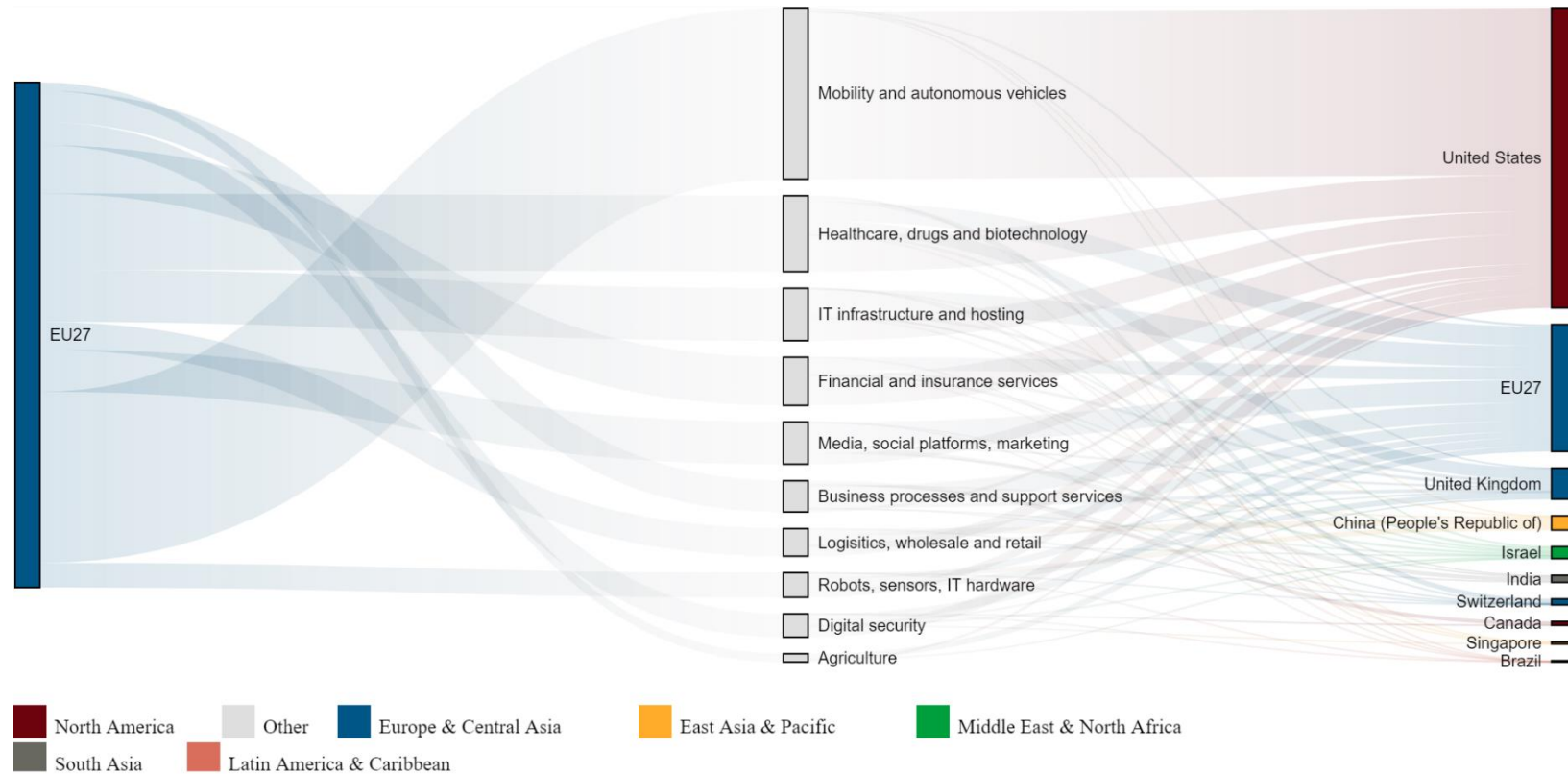
Source: OECD.AI (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 06/09/2021, www.oecd.ai.

Figure D.4. **Investment flow of German VC investors in 2020**

Flow of German VC in value to what industry and to what country of AI firm

Source: OECD.AI (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 06/09/2021, www.oecd.ai.

Figure D.5. Investment flow of French VC investors in 2020

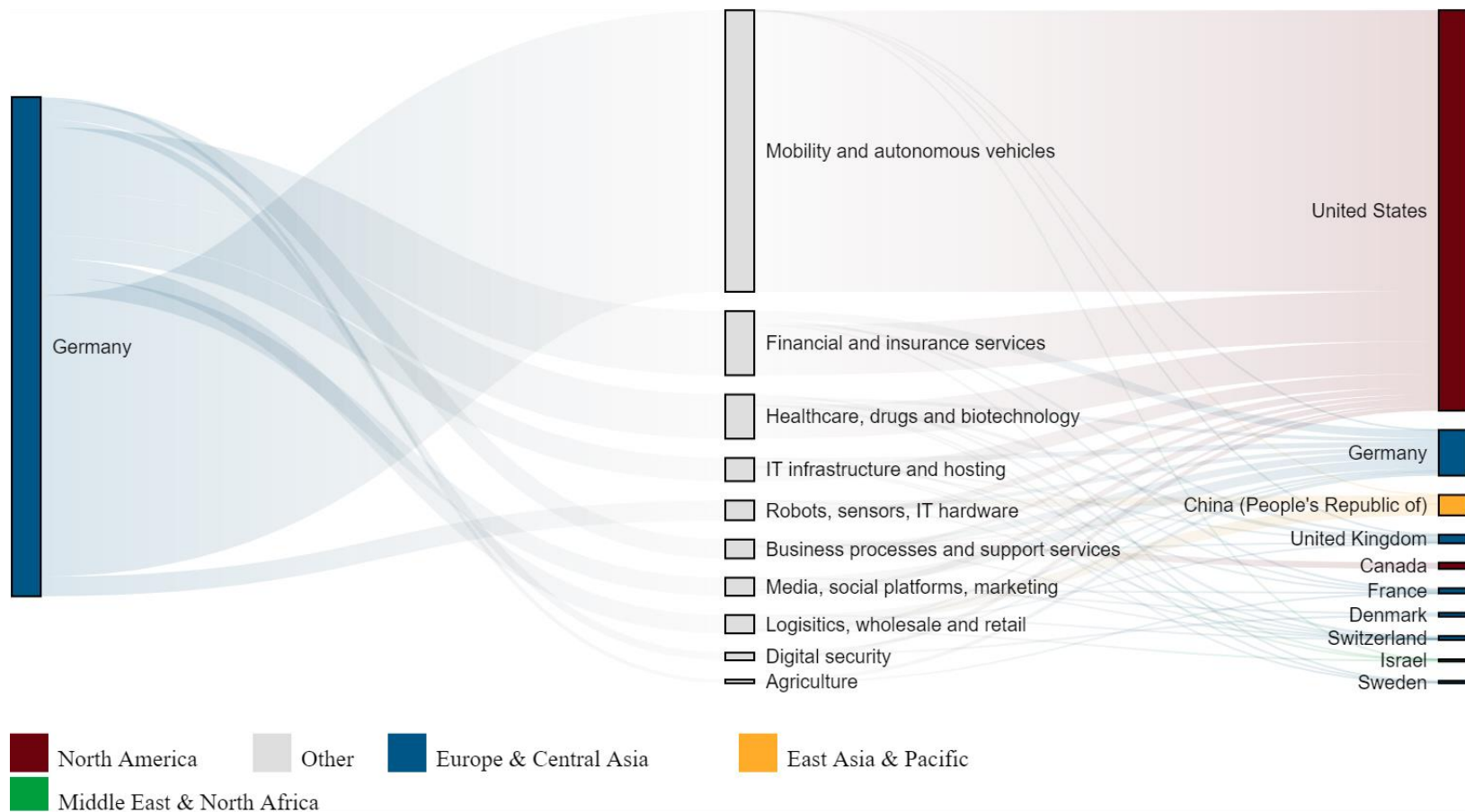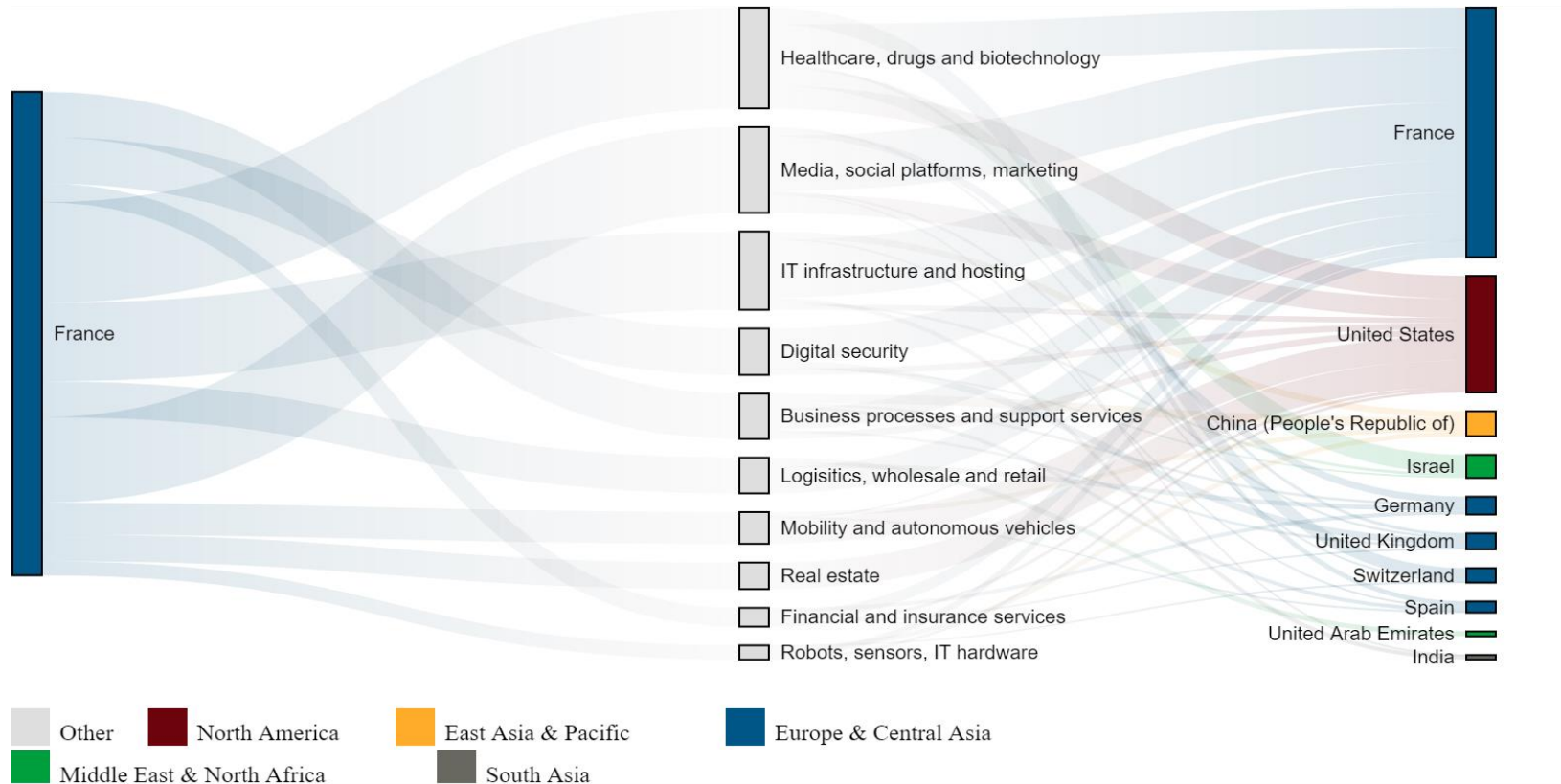Flow of France VC in value to what industry and to what country of AI firm

Source: OECD.AI (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 06/09/2021, www.oecd.ai.

Annex E. Impact of estimations per country

Table E.1. Impact of estimating amounts relative to amounts reported per country

VC deals with AI firms from 2012 to 2020; excluding countries with less than 5 reported deals

Aggregate	Economy	Total number of reported deals	Number of deals with an amount reported	% deals with no amount reported	Number of deals with amount estimated	Number of deals no amount can be estimated	% deals with no amount reported nor estimated	Reported deal amount (USD,mn)	Estimated missing amount (USD,mn)	Total amount (USD,mn)	% amount which is estimated
Canada	Canada	594	471	21%	122	1	0%	3 916	309	4 224	7%
China	China	4 059	1 484	63%	452	2 123	52%	82 137	10 064	92 200	11%
EU27	Germany	480	275	43%	110	95	20%	3 985	690	4 675	15%
-	France	416	379	9%	37	-	0%	2 507	78	2 585	3%
-	Spain	202	177	12%	25	-	0%	718	30	748	4%
-	Sweden	152	139	9%	12	1	1%	530	14	544	3%
-	Belgium	36	32	11%	4	-	0%	418	7	425	2%
-	Ireland	101	93	8%	7	1	1%	348	20	368	6%
-	Finland	83	71	14%	12	-	0%	305	23	328	7%
-	Netherlands	86	62	28%	24	-	0%	289	50	338	15%
-	Denmark	66	50	24%	12	4	6%	245	24	270	9%
-	Austria	51	39	24%	5	7	14%	234	4	238	2%
-	Italy	73	67	8%	6	-	0%	134	6	140	4%
-	Poland	41	31	24%	3	7	17%	93	7	100	7%
-	Hungary	28	25	11%	2	1	4%	91	1	92	1%
-	Czech Republic	14	12	14%	1	1	7%	48	1	49	2%
-	Cyprus[1]	9	6	33%	-	3	33%	48	0	48	0%

-	Slovak Republic	7	7	0%	-	-	0%	42	0	42	0%
-	Portugal	26	20	23%	5	1	4%	32	5	37	14%
-	Luxembourg	12	11	8%	-	1	8%	20	0	20	0%
-	Estonia	21	19	10%	1	1	5%	16	1	16	4%
-	Lithuania	13	13	0%	-	-	0%	12	0	12	0%
-	Slovenia	9	4	56%	-	5	56%	7	0	7	0%
-	Romania	9	6	33%	1	2	22%	7	1	7	8%
-	Bulgaria	8	8	0%	-	-	0%	5	0	5	0%
-	Greece	2	1	50%	-	1	50%	3	0	3	0%
-	Croatia	1	1	0%	-	-	0%	1	0	1	0%
-	Latvia	2	2	0%	-	-	0%	0	0	0	0%
India	India	765	518	32%	248	-1	0%	3 133	282	3 415	8%
Israel	Israel	621	493	21%	122	6	1%	5 368	559	5 926	9%
Japan	Japan	775	496	36%	262	17	2%	3 396	548	3 944	14%
Korea	Korea	384	252	34%	82	50	13%	1 110	165	1 275	13%
Other countries	Australia	188	156	17%	31	1	1%	1 003	100	1 103	9%
-	Brazil	124	97	22%	27	-	0%	899	51	951	5%
-	Switzerland	183	127	31%	54	2	1%	828	183	1 011	18%
-	Chinese Taipei	25	17	32%	4	4	16%	413	37	450	8%
-	Norway	43	31	28%	8	4	9%	289	25	314	8%
-	South Africa	38	27	29%	6	5	13%	152	4	156	3%
-	Indonesia	53	21	60%	5	27	51%	148	91	238	38%
-	United Arab Emirates	39	27	31%	12	-	0%	135	26	160	16%
-	Iceland	5	5	0%	-	-	0%	134	0	134	0%
-	Chile	19	12	37%	4	3	16%	128	3	131	2%

-	Russia	51	40	22%	11	-	0%	85	11	96	12%
-	Mexico	29	20	31%	8	1	3%	81	20	101	20%
-	New Zealand	26	23	12%	2	1	4%	79	3	81	3%
-	Jordan	9	6	33%	-	3	33%	27	0	27	0%
-	Turkey	14	11	21%	1	2	14%	19	1	20	4%
-	Philippines	12	8	33%	2	2	17%	17	2	19	10%
-	Kenya	12	7	42%	3	2	17%	15	9	24	36%
-	Nigeria	10	4	60%	-	6	60%	13	0	13	0%
-	Egypt	13	5	62%	4	4	31%	12	2	14	11%
-	Viet Nam	24	6	75%	3	15	63%	11	6	17	36%
-	Colombia	8	5	38%	3	-	0%	7	8	15	53%
-	Malaysia	17	6	65%	8	3	18%	7	16	23	70%
-	Argentina	12	6	50%	1	5	42%	6	0	7	3%
-	Ukraine	8	6	25%	2	-	0%	6	1	7	12%
-	Saudi Arabia	6	5	17%	-	1	17%	4	0	4	0%
Singapore	Singapore	345	241	30%	95	9	3%	2 074	269	2 343	11%
United Kingdom	United Kingdom	1 158	935	19%	223	-	0%	8 858	709	9 567	7%
United States	United States	8 899	7 255	18%	1 644	-	0%	165 434	8 080	173 513	5%
Total	-	**20 549**	**14 395**	**30%**	**3 719**	**2 435**	**12%**	**290 117**	**22 546**	**312 663**	**7%**

Source: OECD.AI (2021), processed by JSI AI Lab of Slovenia, based on Preqin data of 23/04/2021, www.oecd.ai

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