European framework on ethical aspects of artificial intelligence, robotics and related technologies

European added value assessment

STUDY

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The EU can become a global standard-setter in the area of artificial intelligence (AI) ethics. Common EU legislative action on ethical aspects of AI could boost the internal market and establish an important strategic advantage. While numerous public and private actors around the globe have produced ethical guidelines in this field, there is currently no comprehensive legal framework. The EU can profit from the absence of a competing global governance model and gain full 'first mover' advantages. Building on the EU's economic and regulatory powers, common EU legislative action has great potential to provide European industry with a competitive edge. Furthermore, EU action can facilitate the adoption of EU standards globally and ensure that the development, uptake and diffusion of AI is based on the values, principles and rights protected in the EU. Those benefits cannot be achieved by actions of individual Member States. Thus, the success and benefits of EU action are contingent on the ability of the EU to take timely, common legislative action and to back this action up with strong democratic oversight, accountability and enforcement. The analyses of this **European added value assessment suggest that a common EU framework on ethics has the potential to bring the European Union €294.9 billion in additional GDP and 4.6 million additional jobs by 2030.**

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Executive summary

This European added value assessment (EAVA) evaluates the added value that could potentially be generated for the EU as a result of a joint EU approach to the ethical aspects of artificial intelligence (AI), robotics and related technologies. The analysis provides a qualitative and quantitative assessment of the overall net impact of taking collective EU action versus individual actions by Member States. The macro-economic impact of EU action on the ethical aspects of AI are estimated using a computable general equilibrium model (CGE). Based on the quantitative and qualitative assessment the key conclusion of this EAVA is that a **common EU approach to ethical aspects of AI has the potential to generate up to €294.9 billion in additional GDP and 4.6 million additional jobs for the European Union by 2030.**

Three policy options were analysed in order to make a comparative analysis of impacts. Policy option 0 (PO 0) – the status quo or baseline scenario; policy option 1 (PO 1) – 'uniform' common EU action entailing a high degree of harmonisation at EU level; and policy option 2 (PO 2) – 'coordinated' EU action based on joint responsibility between EU and national levels. When it comes to the monetised impact on the EU economy of joint EU action, both PO 1 and PO 2, would benefit all sectors of the EU economy as compared to the PO 0 status quo. The magnitude of impacts in terms of net benefits as compared with the baseline scenario grow over time; however the positive impacts would already be present shortly after the adoption of EU action. Were EU joint action to be taken now, it would have the potential to generate between €182 and €244.5 billion in additional GDP and 3.2 to 4.3 million additional jobs within five years.

In terms of sectoral impacts, it is estimated that over a 10-year horizon (by 2030) EU action on ethical aspects will have the greatest impact – measured as a percentage deviation from a baseline scenario – in the 'arts, entertainment and recreation' sector, which will generate an additional 2 % under PO 1 and 3.3 % under PO 2 as compared to the baseline in terms of real value added. The smallest, but still net positive, impact is estimated in 'public administration, defence, education, human health and social work activities' (+0.6 % (PO 1) and +0.7 % (PO 2). In terms of total factor productivity, it is estimated that EU joint action would have the largest net positive benefit on industry as an economic sector (+0.58 % under PO 1 and +0.7 % under PO 2). The construction sector would benefit most in terms of employment (+4.9 % for PO 1 and +9.3 % for PO 2).

Joint EU action has the potential to generate benefits for the EU economy and individuals and enhance the global competitiveness of the EU as a global player. While numerous public and private actors around the world have produced guidelines in this area, there is currently no comprehensive legal framework. The EU can therefore profit from a lack of competing global regulatory governance models and take full advantage of being the 'first mover'. Building on EU economic and regulatory powers, common EU legislative action enormous potential to provide European industry with a competitive edge and boost the internal market. Furthermore, EU action would facilitate the adoption of EU standards globally and ensure that the development, uptake and diffusion of AI is based on the values, principles and rights protected in the EU. These benefits cannot be achieved by Member States acting alone.

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1. Introduction

The purpose of this European added value assessment (EAVA) is to provide an evidence-based evaluation and assessment to accompany the European Parliament's report on a legislative own-initiative proposal on an EU framework of ethical aspects of artificial intelligence, robotics and related technologies (2020/2012 INL).[1] The report was initiated by the Committee on Legal Affairs (JURI) in accordance with Article 225 of the Treaty on the Functioning of the European Union (TFEU).[2]

1.1. Background

The ethics of artificial intelligence (AI) systems was among the first topics discussed in the EU public sphere in connection with robotics and AI. The European Parliament's first legislative resolution on AI, adopted in 2017, focused primarily on ethics.[3] Likewise, the work of the European Commission on AI, also began with issues relating to ethics. When, in 2018, the European Commission set up a high-level expert group on artificial intelligence (AI HLEG), the first document prepared was entitled Ethics Guidelines for Trustworthy Artificial Intelligence.[4] Ethics remains a central topic triggering ever growing public policy and academic debates in the EU.[5]

This focus and attention to the ethics of AI is justified. Ethical systems provide fundamental frameworks, including principles, values and rules, that define substantive content and boundaries for action or behaviour in a given society.[6] Ethical systems are, therefore, akin to a foundational layer that structures and shapes the very nature of the particular activity. This explains why discussions on robotics and AI in the EU have begun with ethical matters, before moving to other important issues such as, for example, policy action on safety, liability or standards.

1.2. Methodology and scope of the assessment

Academic and policy discussions have so far focused mainly on the ethical implications, guiding values and principles, and moral questions that arise from the development and implementation of AI. This EAVA contributes to this important debate on the ethics of AI from a different perspective. This analysis does not focus on the possible substantive content of ethics rules, but rather on the assessment of the added value of taking common EU action. **The main aim of the EAVA is to assess**

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1 European Parliament, Framework of ethical aspects of artificial intelligence, robotics and related technologies, 2020/2012(INL), rapporteur, Ibán García del Blanco (S&D, Spain).

2 According to Article 225 TFEU the European Parliament has the right to ask the European Commission to take legislative action in a particular area. Article 10 of the Interinstitutional Agreement on Better Law-Making of 13 April 2016, provides that the European Commission commits to respond to a European Parliament request for proposals for Union acts by adopting a specific communication. If the Commission decides not to submit a proposal, it should inform the European Parliament of the detailed reasons therefore, including a response to the analysis on the potential European added value of the measure requested.

3 European Parliament resolution of 16 February 2017 with recommendations to the Commission on Civil Law Rules on Robotics (2015/2103(INL)), see in particular, Annex to the motion for a resolution: detailed recommendations as to the content of the proposal requested, which includes the proposal for the EU Code of Ethical Conduct, which covers the Code of Ethical Conduct for Robotics Engineers and the Code for Research Ethics Committees.

4 High-level expert group on artificial intelligence, The Ethics Guidelines for Trustworthy Artificial Intelligence (AI), 2018.

5 See for example, the recent European Parliament publication, The ethics of artificial intelligence: Issues and initiatives, STOA, 2020. This publication provides a comprehensive overview of the main international, EU and national guidelines and frameworks relating to the ethics of AI technologies.

6 The interplay between law and ethics is explained by Hielke Hijmans and Charles D. Raab as follows: 'Laws stipulate what must, can or cannot be done. Ethical notions about good and bad behaviour lie behind these stipulations '. See footnote 24 below, Ethical Dimensions of the GDPR. For a discussion, see, for example, M. Hildebrandt, Law for Computer Scientists and Other Folk, Oxford University Press, 2020.

the potential added value that can be generated for the EU as a result of *common EU approach* on ethical aspects of artificial intelligence, robotics and related technologies. Therefore, the objective of this EAVA is to provide an assessment of the overall net impact of taking collective EU action versus individual actions by Member States. The concept and evaluation of European added value (EAV) is both a legal obligation underpinning EU legal principles of subsidiarity and proportionality and a socio-economic measure of effectiveness and efficiency, which helps to evaluate the costs and benefits of an EU action against individual measures of Member States.[7]

European added value (EAV) is assessed both qualitatively and quantitatively. Macro-economic impacts of EU action on ethical aspects of AI, robotics and related technologies are estimated using a **computable general equilibrium model (CGE)**.[8] The quantitative model structure follows the 2016 impact assessment model[9] and assumes that the open economy is divided into sectors. The scale of potential future impacts of EU action per economic sector fed into the overall CGE model is estimated on the basis of the inputs collected through an expert survey.[10] The overall model is constructed and calibrated on the basis of Eurostat data.[11] Input for five types of shock: labour demand, labour supply, product demand, investment, and total factor productivity (TFP), as well as data to calibrate the baseline scenario, is based on the results from expert surveys and interviews.[12] The qualitative assessment is based on a **literature review and inputs from the expert survey**.

This EAVA is an initial quantitative analysis estimating the added value of EU action on ethics. There were important constraints and limitations when it came to designing the economic model and quantification, including: (1) the absence of a widely accepted or established methodology for this type of quantification, (2) the absence of a commonly agreed understanding of the definition of AI and substantive scope of EU action on ethics, and (3) the extremely limited availability of structured historical data or projections in terms of diffusion and acceptance of AI, needed to estimate the impacts for a 10-year horizon.[13] To compensate for the limited availability of the data necessary for the CGE model, the expert survey was designed specifically for this EAVA analysis. This small scale survey was designed to complement existing data and provide, to the degree possible, a broad perspective of expertise and opinions that could be considered representative for the overall dynamics of the economy.[14] The survey involved experts representing various sectors of the EU

[7] European added value (EAV) is understood as the positive net benefit of EU action compared with individual actions at Member State level.

[8] The quantitative assessment of EAV was informed by an external study commissioned by the EPRS European Added Value Unit, research paper: European Added Value of Framework of Ethical Aspects of AI, Robotics and Related Technologies, 2020. The results of the study, including a detailed methodology for the analyses is included in the Annex.

[9] WIK-Consult, Ecorys and VVA Consulting study prepared for the European Commission, Support for the preparation of the impact assessment accompanying the review of the regulatory framework for e-communications, 2016.

[10] The quantitative assessment focuses on eight economic sectors: transport, health care, the automotive industry, construction, financial services, energy, telecommunications and agriculture. The overall impact on the EU economy is estimated on the basis of the assessment of those sectors. For the detailed methodology, see the research paper annexed to this study.

[11] With a limited number of coefficients calibrated on the basis of values taken from a review of the relevant literature.

[12] The expert inputs were collected using the Delphi method, for details see the research paper annexed to this study.

[13] The key constraint of this kind of quantitative analysis is the emerging nature of the AI sector itself. There is a high degree of uncertainty relating to the speed of uptake and diffusion of AI. This uncertainty results in a wide range of differences in estimates in terms of overall AI market growth and its impact on specific sectors.

[14] However, it must be acknowledged that survey has a limited sample of experts and cannot be considered to be strictly speaking fully representative, akin for example to Eurobarometer data (which is unfortunately is not available for this

economy, to adjust and account for sectoral differences. Although every effort was made to limit the negative impacts of the limitations, they undoubtedly affected the sensitivity of the final results of the quantitative assessment. Accordingly, **considering those limitations, the quantitative results of this EAVA presented below provide only initial, indicative results, which would need further elaboration and verification with additional data in the future**.[15]

The EAVA is structured as follows: after this short introduction, Chapter 2 outlines the current EU regulatory framework, which though not specifically adopted for AI systems, is nevertheless applicable. Chapter 3 presents an analysis of the limitations of the existing framework. Building on this analysis, Chapter 4 explores on the need to take an EU action and discusses possible EU policy responses. Finally, Chapter 5 provides an overall assessment of the European added value of taking joint action to develop an EU framework on ethical aspects of AI, robotics, and related technologies.

type of analysis). For this survey, 43 experts confirmed participation and 38 completed the first round of a survey in full, please refer to the Annex for details.

[15] The CGE model itself also has limitations, including availability of historical, structured data and the specific economic structure the model is based on.

2. The European legal and policy framework for AI

There is no legally binding, horizontal, EU legal instrument that specifically establishes a regulatory framework for AI. However, the development of AI systems, including data collection and processing, as well as, for example, possible outcomes in terms of safety, liability or discrimination are already covered by existing EU legislation and international law instruments.[16] This chapter presents a non-exhaustive, brief overview of the main EU law provisions that are shaping the discussion on AI ethics.

The EU-funded Horizon 2020 (H2020) SIENNA project conducted an in-depth analysis of the legal debate and identified the following nine main categories of existing EU law relating to the debate on AI regulation.[17]

Table 1 – AI legal issues and examples of relevant EU legislation

Main legal issue/area	EU legislation applicable
Algorithmic transparency	Regulation 2016/679; Directive 206/680
Unfairness, bias and discrimination	Article 2, 3(3), 9 TEU; Article 10 TFEU; Article 20-26 EU Charter on Fundamental Rights; Council Directive 200/78/EC; Council Directive 2000/43/EC; Council Directive 2004/113/EC; Directive 2006/54/EC, Council Directive 79/7/EEC, Directive 2010/41/EU, Council Directive 2010/18/EU, Regulation (EU) 2016/679, Directive (EU) 2016/680, Directive (EU) 2016/681.
Intellectual property issues	Article 118 TFEU, Article 17 (2) EU Charter on Fundamental Rights; Directive 2001/29/EC; Directive 2006/115/EC; Directive 2001/84/EC; Directive 2009/24/EC; Directive 2004/48/EC; Directive 96/9/EC; Directive 2012/28/EU; Directive 98/71/EC; Regulation (EU) No 1257/2012; Regulation (EU) 2017/1001; Directive (EU) 2016/943;
Legal personhood of AI	Not covered.
Vulnerability and cybersecurity	Directive (EU) 2016/1148; Regulation (EU) No 910/2014; Directive 2013/40/EU; Regulation (EU) No 526/2013; Directive 2002/58/EC
Impact of AI on workers	Article 3(1)(3) TEU; Article 9, 107(3)(a), Articles 145-166 TFEU; Articles 14-15, 27-32 EU Charter of Fundamental Rights; Regulation (EU) No 1304/2013
Privacy and data protection	Articles 7-8 EU Charter of Fundamental Rights; Regulation (EU) 2016/679; Directive (EU) 2016/680; Directive (EU) 2016/681; Directive 2002/58/EC
Liability	Articles 4(2)(f), 12, 114 and 169 TFEU; Articles 38, 47 EU Charter of Fundamental Rights; Council Directive 85/374/EEC
Accountability for harm	Regulation (EU) 2016/679

Source: Table 5: AI Legal issues and examples of relevant EU legislation, SIENNA project.[18]

[16] For an overview of international legal instruments applicable to AI in general see, for example, publications of the EU SIENNA project, specifically deliverable D4.2. Analysis of the legal and human rights requirements for AI and robotics in and outside the EU, 2019.

[17] The SIENNA project 'Stakeholder informed ethics for new technologies with high socio-economic and human rights impact, D4.2. Analysis of the legal and human rights requirements for AI and robotics in and outside the EU, 2019.

[18] Ibid, SIENNA project, pp. 41-44.

The following sections discuss selected EU law provisions in more detail.

2.1. EU primary law: Charter of Fundamental Rights of the European Union

Charter of Fundamental Rights of European Union does not specifically address AI. It does, however, provide important, fundamental guidance and legal obligations, which inform the main analyses on AI. For a discussion on the ethical framework of AI, it is particularly relevant to highlight three paragraphs in the Preamble to the Charter.[19]

First, the Charter emphasises **the human-centric nature of EU activities**, and states:

> *'Conscious of its spiritual and moral heritage, the Union is founded on the indivisible, universal values of human dignity, freedom, equality and solidarity; it is based on the principles of democracy and the rule of law. It places the individual at the heart of its activities, by establishing the citizenship of the Union and by creating an area of freedom, security and justice.'*

Second, the Charter underlines that the EU seeks to promote **balanced and sustainable development** while contributing to the preservation of common values and respect for diversity:

> *'The Union contributes to the preservation and to the development of these common values while respecting the diversity of the cultures and traditions of the peoples of Europe as well as the national identities of the Member States and the organisation of their public authorities at national, regional and local levels; it seeks to promote balanced and sustainable development and ensures free movement of persons, services, goods and capital, and the freedom of establishment.'*

Third, the Charter stresses the **need to protect fundamental rights in the light of scientific and technological developments**:

> *'To this end, it is necessary to strengthen the protection of fundamental rights in the light of changes in society, social progress and scientific and technological developments by making those rights more visible in a Charter.'*

In addition to those general principles, which inform and reflect the constitutional structure and functioning of the EU, there are also a number of specific rights that are particularly relevant to the discussion on ethics of AI. Those rights include but are not limited to: protection of human dignity (Article 1), freedom of thought, conscience and religion (Article 10), freedom of assembly and of association (Article 12), equality before the law (Article 20), and non-discrimination (Article 21).

Accordingly, the EU Charter of Fundamental Rights, already provides an existing layer of governance and protection. This protection is twofold: first, the Charter protects individuals from state intervention, and, second, it imposes on EU Member States an 'obligation to protect'. This obligation to protect means that a state is obliged to protect the freedoms enshrined in the Charter from third-party interference. Specifically as applies to AI this may entail, for example, 'enacting appropriate legislation that applies to relations between private individuals or by creating specific approval procedures for placing goods or services on the market that could endanger the fundamental rights of its users'.[20] To put it succinctly, the Charter imposes obligation on the states to ensure that actions by any party, human or artificial intelligence driven, do not lead to violation of Charter protected rights and principles, for example, on prohibiting justified discrimination.

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[19] Charter of Fundamental Rights of the European Union, OJ C 326 of 26.10.2012; emphasis added.

[20] D. Schneeberger, K. Stöger and A. Holzinger, The European legal framework for medical AI, International Cross-Domain Conference for Machine Learning and Knowledge Extraction, Springer, Cham, 2020.

2.2. EU secondary law

EU secondary law relating specifically to AI systems is only just emerging and it is likely that a number of new legislative acts will be proposed in the 2020-2021 period.[21] There are currently only seven EU regulations or directives in force that explicitly mention 'artificial intelligence', the oldest regulation, on the coordination of social security systems, dates back to 2009.[22] This, however, does not mean that this is the exhaustive list of EU secondary law that is applicable to the discussions underlying the AI ethical debate.

2.2.1. The General Data Protection Regulation (GDPR)[23]

The most widely discussed EU secondary law in the context of AI and ethics is the GDPR. There is a lively debate in the academic literature, across the disciplines, on the scope of the GDPR as specifically applies to the ethical dimension of AI. Some scholars argue that GDPR must be read narrowly as a legal instrument regulating strictly personal data, while others suggest a broader reading of GDPR and claim that GDPR incorporates ethical values and thus provides a normative, value-driven framework, encompassing, among other things, fundamental rights and principles.[24] Hielke Hijmans and Charles D. Raab, for example, argue there is a close relationship between data protection and ethics: 'The fundamental right to data protection gives an individual a claim that her data is being processed in a fair manner. Other – moral – value notions behind data protection are human dignity and personal autonomy, which are notions with an obvious ethical dimension. In addition, ethical considerations play a role in the application of data protection law, including the GDPR'.[25]

It is beyond the scope of this analysis to engage in this debate.[26] However, based on the available literature, the five provisions of the GDPR that are most frequently discussed as specifically relevant to the debate on AI and ethics are those relating to:

1.1 human oversight,[27]

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21 Consider a number of own legislative initiative reports in the European Parliament (2020/2014(INL); 2020/2012(INL)) and the adjusted 2020 European Commission work programme.

22 Directive (EU) 2019/1024 of the European Parliament and of the Council of 20 June 2019 on open data and the re-use of public sector information; Regulation (EU) 2019/452 establishing a framework for the screening of foreign direct investments into the Union; Regulation (EU) 2018/1807 on a framework for the free flow of non-personal data in the European Union; Regulation (EC) No 987/2009 laying down the procedure for implementing Regulation (EC) No 883/2004 on the coordination of social security systems; Commission Implementing Regulation (EU) 2020/1030 of 15 July 2020 laying down the technical specifications of data requirements for the topic 'ICT usage and e-commerce ' for the reference year 2021, pursuant to Regulation (EU) 2019/2152; Commission Regulation (EU) 2019/424 of 15 March 2019 laying down ecodesign requirements for servers and data storage products pursuant to Directive 2009/125/EC; Council Regulation (EU) 2018/1488 of 28 September 2018 establishing the European High Performance Computing Joint Undertaking.

23 Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (OJ 2016 L 119/1).

24 See for example H. Hijmans and CD Raab, 'Ethical Dimensions of the GDPR', in M. Cole and F. Boehm (eds.), *Commentary on the General Data Protection Regulation*, Edward Elgar, 2018.

25 H. Hijmans and C.D. Raab, 'Ethical Dimensions of the GDPR', in M. Cole and F. Boehm (eds.), *Commentary on the General Data Protection Regulation*, Edward Elgar, 2018.

26 M. Brkan, AI-supported decision-making under the general data protection regulation. Proceedings of the 16th edition of the International Conference on Artificial Intelligence and Law. 2017; M. Brkan, 'Do algorithms rule the world? Algorithmic decision-making and data protection in the framework of the GDPR and beyond', *International Journal of Law and Information Technology*, Vol. 27, 2019, pp. 91–121.

27 Article 5, recital 71 GDPR.

2.1 the obligation to provide information and access to data and right to explanation,[28]
3.1 privacy by design,[29]
4.1 data protection impact assessment,[30] and
5.1 the prohibition of automated individual decision-making.

The prohibition of automated individual decision-making, including profiling, in Article 22 GDPR states:

> *'The data subject shall have the right not to be subject to a decision based solely on automated processing, including profiling, which produces legal effects concerning him or her or similarly significantly affects him or her.'*[31]

2.2.2. Product safety and liability

There is a large body of EU regulation relating to consumer protection, product safety and liability. This body of regulation establishes rules, principles and standards, what is considered to be 'safe' and under what conditions; for example, defective products trigger liability for a producer. This body of existing law, among other rights and principles, codifies the underlying common accord on what is acceptable to and expected by consumers. One example might be a level of safety or a guiding framework on the distribution of risks in society among economic actors and consumers. This body of law, arguably also plays a role in the discussion on the ethical framework that should be applicable to AI systems.[32]

Among other pieces of legislation, with general scope of application, particularly relevant are: the Machinery Directive,[33] the Radio Equipment Directive,[34] the Toy Safety Directive,[35] the General Product Safety Directive,[36] the Product Liability Directive, and the Services Directive.[37] This body of law is further supplemented by sector-specific legislation, such as that relating to medical devices or unmanned aircraft, for example.[38]

[28] Article 13 and 14 GDPR.

[29] Article 25 GDPR.

[30] Article 35 GDPR.

[31] Similarly, see also Article 11, 'Automated individual decision-making' of Directive 2016/680 on Data Protection in Criminal Matters. Specifically on the analysis of Article 22 GDPR, see for example Bryce Goodman and Seth Flaxman, 'European Union regulations on algorithmic decision-making and a "right to explanation"', *AI magazine*, Vol. 38(3), 2017, pp. 50-57.

[32] For an analysis of the interplay between existing EU law and AI see e.g. G. Mazzini, 'A System of Governance for Artificial Intelligence through the Lens of Emerging Intersections between AI and EU Law', in A. De Franceschi and R. Schulze (eds.), *Digital Revolution – New challenges for Law*, 2019.

[33] Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast) (Text with EEA relevance).

[34] Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC Text with EEA relevance.

[35] Directive 2009/48/EC of the European Parliament and of the Council of 18 June 2009 on the safety of toys (Text with EEA relevance).

[36] Directive 2001/95/EC of the European Parliament and of the Council of 3 December 2001 on general product safety (Text with EEA relevance).

[37] Directive 2006/123/EC of the European Parliament and of the Council of 12 December 2006 on services in the internal market.

[38] EU law specific to: 1) medical devices: Regulation (EU) 2017/745 (OJ 2017 L 117/1); Regulation (EU) 2017/746 (OJ 2017 L 117/176); and to 2) drones: Regulation (EU) 2018/1139 (OJ 2018 L 212/1).

2.2.3. Digital single market-related legislation

There are also a number of digital single market-related legal acts that provide rights and establish protection relating to the digital environment, specifically the E-Privacy Directive[39] and the e-Commerce Directive.[40] Furthermore, there is a recent regulation on algorithms in the EU financial markets. According to Article 26 of the EU Markets in Financial Instruments Directive 2 (MiFID 2) investment firms are obliged to include details of the computer algorithms responsible for making investment decisions and for executing transactions.[41]

In conclusion, the existing body of EU primary and secondary law already provides a foundation that forms a basis for discussion in the AI and ethics debate. Yet the existing norms might not necessarily always provide explicit references to AI in connection with fundamental principles. This is clearly a limitation that should be addressed in a future EU legislative action. However, the debate on the GDPR, already indicates that there is an emerging broader understanding on the application and implication of fundamental principles and values protected by existing EU law relevant to AI systems.

2.3. EU initiatives

Ethics are at the centre of the European Union debate on AI.[42] The EU has made a strong commitment to develop a 'human-centric' approach.[43] The European Commission white paper on artificial intelligence - A European approach to excellence and trust – includes a strong ethical stance and states that: 'The European approach for AI aims to promote Europe's innovation capacity in the area of AI while supporting the development and uptake of ethical and trustworthy AI across the EU economy. AI should work for people and be a force for good in society'.[44] The EU institutions have stressed repeatedly that the European approach should be developed on the basis of respect for European values, principles and cultural preferences as well as higher standards of protection of individual and social risks.[45] The EU takes a particularly strong stance on issues concerning privacy, data protection and discrimination rules. This makes the EU's strategic approach to AI substantially different from the US one, which focuses on private-sector initiatives and is self-regulation driven, and the Chinese strategy, which prioritises a government-led approach, with substantial coordination of private and public sectors.[46]

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39 Directive 2002/58/EC of the European Parliament and of the Council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector, OJ L 201 of 31 July 2002.

40 Directive 2000/31/EC of the European Parliament and of the Council of 8 June 2000 on certain legal aspects of information society services, in particular electronic commerce, in the Internal Market, OJ L 178 of 17 July 2000.

41 M. Kritikos, Artificial intelligence *ante portas*: Legal & ethical reflections, EPRS, European Parliament, 2019.

42 This section provides an overview of some initiatives taken by the European Parliament and European Commission. The debate, however, is considerably broader, involving other EU institutions, bodies and agencies. The ongoing research project by the EU Agency for Fundamental Rights has identified 40 EU policy initiatives in the area of AI by a diverse set of EU actors. A complete overview of all EU initiatives is beyond the scope of this analysis.

43 See for example the work of the high-level expert group on artificial intelligence and policy initiatives of the European Commission.

44 European Commission white paper on artificial intelligence - A European approach to excellence and trust, COM(2020) 65 final.

45 See for instance the EU institutions' policy documents cited in this chapter.

46 T. Madiega, EU guidelines on ethics in artificial intelligence: Context and implementation, EPRS, European Parliament, 2019.

2.3.1. Position of the European Parliament

In its 2017 resolution on civil law rules on robotics and AI, the European Parliament urged the European Commission to analyse and evaluate the impacts of AI.[47] This resolution prioritised six main areas of EU legislative concern: ethics, liability, intellectual property and flow of data, standardisation, employment and institutional coordination and oversight. The resolution also paid significant attention, as a matter of priority, to ethics.[48] It proposed 'a code of ethical conduct for robotics engineers, a code for research ethics committees, a "licence" for designers and a "license" for users'.[49] It also called for the establishment of a European agency for robotics and AI, to provide technical, ethical and regulatory expertise on AI. Parliament also called on the Commission to submit a proposal for a directive on civil law rules on robotics.

Furthermore, in 2019, Parliament adopted an own-initiative-report on a 'Comprehensive European industrial policy on artificial intelligence and robotics'.[50] This resolution again placed a significant focus on ethical issues and specifically included a large section on ethical aspects.[51] The resolution stressed that 'AI research should invest not only in AI technology and innovation developments but also in AI-related social, ethical and liability areas', and that 'any AI model deployed should have ethics by design'. The resolution specifically mentions four sets of issues in relation to the ethical discussion: 1) human-centric technology; 2) embedded values in technology – ethical-by-design; 3) decision-making – limits to the autonomy of artificial intelligence and robotics and 4) transparency, bias and explainability of algorithms.

Most recently, in June 2020 the European Parliament decided to set up a special committee on artificial intelligence in a digital age.[52]

2.3.2. Position of the European Commission

In 2017, already under the Juncker Commission, the relevance of AI technologies and the need of the EU to lead in the field was acknowledged[53] and in 2018 a specific communication on 'Artificial intelligence for Europe'[54] was adopted followed by a coordinated plan on artificial intelligence.[55] European Commission initiatives have focused on the opportunities of AI and how the EU could benefit from it while also examining the challenges that could be caused by these systems. In 2018, the Commission appointed high-level expert group on artificial intelligence, which published EU AI ethical guidelines and recommendations.[56] In 2019, the European Commission President, Ursula von der Leyen, announced legislative proposals for a coordinated EU approach to the human

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[47] European Parliament resolution of 16 February 2017 with recommendations to the Commission on Civil Law Rules on Robotics (2015/2103(INL)).

[48] See, in particular, paragraphs 10 to 17 of the 16 February 2017 resolution.

[49] European Parliament resolution of 16 February 2017 with recommendations to the Commission on Civil Law Rules on Robotics (2015/2103(INL)), Introduction, paragraph W.

[50] European Parliament resolution of 12 February 2019 on a comprehensive European industrial policy on artificial intelligence and robotics (2018/2088(INI)).

[51] See paragraphs 138 to 180 of the 12 February 2019 resolution.

[52] European Parliament decision of 18 June 2020 on setting up a special committee on artificial intelligence in a digital age, and defining its responsibilities, numerical strength and term of office (2020/2684(RSO)).

[53] European Commission communication on the mid-term review on the implementation of the digital single market strategy, COM(2017) 228 final, May 2017.

[54] European Commission communication on artificial intelligence for Europe, COM(2018) 237, April 2018.

[55] European Commission communication on building trust in human-centric artificial intelligence, COM(2019)168 final, 8 April 2019.

[56] High-level expert group on artificial intelligence, Ethics guidelines for trustworthy AI, European Commission, 2019.

and ethical implications of AI.[57] In 2020, the European Commission published a white paper aiming to foster a European ecosystem of excellence and trust in AI[58] and a report and the safety and liability aspects of AI.[59]

57 Ursula von der Leyen, A Union that strives for more. My agenda for Europe: Political guidelines for the next European Commission 2019-2024, p.13: 'In my first 100 days in office, I will put forward legislation for a coordinated European approach on the human and ethical implications of Artificial Intelligence'.

58 European Commission white paper on artificial intelligence – A European approach to excellence and trust, COM(2020) 65 final, 19 February 2020.

59 European Commission Report on the safety and liability implications of artificial intelligence, the internet of things and robotics, COM(2020) 64 final.

3. Emerging regulatory framework and policy context on ethical aspects of AI: Key gaps and challenges

The current normative debate on AI and ethics does not start or emerge in a regulatory vacuum. Chapter 2 above discussed existing EU legislative provisions that inform the current debate on the ethics of AI. However, analysis of the existing legal framework and ethical requirements also points to a number of important and diverse gaps and risks, both related to general issues of governance and also issues relating to the limits of the existing law to adapt to new challenges and manage new risks. **This chapter focuses on an analysis of the main gaps and challenges relevant to the discussion on the necessity and benefits of common EU action on the ethics of AI.**[60]

3.1. Static regulatory frameworks as a risk when applied to dynamic AI systems and restrictions to ethics

Current systems of fundamental values and public regulation are based on the underlying assumption that action directly or indirectly triggered and caused by a human is the main source of danger. Accordingly, international, European and national laws have developed a number of values, norms, principles and rules to prevent and protect against individual and collective harm potentially caused by fellow humans. The red lines, now codified in the so-called *jus cogens* provisions of international law, are universal norms from which no derogations are allowed.[61]

Technology, from its basic to its increasingly sophisticated applications has always been a part of human activity and public co-existence. Hence, for example, existing regulatory provisions in all European legal systems that aim to protect society and impose liability on individuals who are engaged in particularly dangerous activities (e.g. nuclear plants) or who use dangerous things (e.g. explosives).[62] However, the technological nature of AI systems, both those already manifested and probably even more so their upcoming features and applications, could potentially provide a novel level of disruption.[63]

More specifically, the 'a) complexity, b) opacity, c) openness, d) autonomy, e) predictability, f) data-drivenness, and g) vulnerability' of AI could create challenges for the existing normative systems and regulatory frameworks.[64] Legal systems are, broadly speaking, facing two sets of interrelated

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[60] Therefore, in-depth, substantive, normative analysis of the fitness of EU law and policy and normative desirability of ethical norms are beyond its scope.

[61] Those universal norms cover, for example, slavery, torture, genocide, war of aggression, or crimes against humanity.

[62] For a discussion see T. Evas, Civil liability regime for artificial intelligence: European Added Value Assessment, European Parliamentary Research Service, PE 654.178, September 2020.

[63] In general legal systems face new challenges with every new technology developed and used.

[64] It is beyond the scope of this assessment to provide a detailed account of those possible challenges individually. Consider for example, the element of 'autonomy ' of AI systems, which may lead to a decision and ultimately an action not directly based on human input of any particular person or even any structured dataset but rather, for example, are based on a set of complex algorithms fed with broadly acquired and unstructured data. In this situation, the attribution of the result (and possible harm) might be extremely difficult (although arguably still possible). Maja Brkan, for example, summarises the obstacles to algorithmic transparency, suggesting that that there are several obstacles that stand in the way of giving a data subject a meaningful explanation of logic behind algorithmic decisions. The obstacles to algorithmic transparency are therefore the following: '1) technical obstacles, 2) intellectual property obstacles and 3) state secrets and other confidential information of state authorities'. See Maja Brkan, AI-supported decision-making under the general data protection regulation, proceedings of the 16th edition of the International Conference on Artificial Intelligence and Law. 2017, p.6. Jenna Burell, meanwhile, distinguishes between three types of opacity of algorithms: corporate or state secrecy; technical illiteracy; and opacity arising from characteristics of

challenges. First, 'adaptation', which means existing legal principles need to be adjusted and applied, considering the seven specific dimensions of AI mentioned above.[65] Second, 'anticipation', which means that existing legal systems need to be able to provide dynamic legal mechanisms to safeguard from and redress externalities that could potentially emerge owing to new risks.[66]

Consequently, the main aim and the challenge of the framework of ethical aspects of AI is to adapt or complement the existing system of rules so that those rules provide **clear ex-ante, dynamic and forward-looking guidance** for development and application of AI that adheres to the ethical principles and values of a given society. This guidance should provide a framework within which the benefits of the emerging digital technologies could be fully harnessed in our societies without jeopardising or threatening our human norms and values or imposing risks that are not covered under the current norms.

3.2. The absence of a common understanding and definition of AI as a challenge for further action

Numerous analyses suggest that there is no common understanding on a definition of AI in the EU. Artificial intelligence, robotics and algorithms are widely used expressions, the understanding of which varies between the general public and experts.[67] This makes the discussion on the ethical principles even more difficult and complex.[68] It leads to challenges in understanding in connection with the scope of both the normative content and the application of the rules.[69]

This analysis of the EAV, as pointed out above, focuses mainly on an analysis of joint action versus possible individual actions by the Member States. This analysis is therefore less sensitive to possible differences or issues relating to the precise definition of AI or the scope of the ethical considerations. For the purpose of the quantitative assessment, discussed below, this EAVA has relied on the definition of 'trustworthy AI' suggested by the high-level expert group on AI.[70] This definition has limitations, however, it is currently the most advanced and best defined approach discussed EU-wide. According to this AI HLEG definition 'trustworthy AI' means that it is lawful (laws and regulations are followed); ethical (ethical values and principles are obeyed), and robust (from technical and social perspectives no harm is created). The AI HLEG definition and ethical

machine learning. See Jenna Burrell, 'How the machine 'thinks': Understanding opacity in machine learning algorithms', *Big Data & Society*, Vol 3(1), 2016.

65 Consider, for example, traditional understandings of legal personality, individual agency, responsibility, autonomy and privacy.

66 For example M. Kritikos, argues that AI itself will soon be used in safety critical applications whether in health-related decisions or in transport. Here regulation is lacking and questions need to be raised on the regulation. Furthermore, the independence of AI systems from developers and operators and their ability to learn and adapt themselves are also challenges to legislators and the enforcement of legislation. This is especially challenging to the rule of law, which relies on predictability and the legal obligation of compensation in the case of unlawful injury. For more detail see M. Kritikos, Artificial intelligence ante portas: Legal & ethical reflections, EPRS, European Parliament, 2019.

67 Tambiama Madiega suggests distinguishing those concepts as following: artificial intelligence – machine learning techniques used to seek and analyse data in large quantities; robotics – to do with programmable machines from conception, design, manufacture and handling; and algorithms and automated decision-making systems – autonomous decision-making, predicting the behaviour of humans and machines, see T. Madiega, EU guidelines on ethics in artificial intelligence: Context and implementation, EPRS, European Parliament, 2019.

68 For a recent review of national strategies and approaches see: The ethics of artificial intelligence: Issues and initiatives, EPRS, European Parliament, March 2020.

69 Here, the discussion relating to a 'narrow' or 'broad' reading of the GDPR is very instructive. See the discussion on secondary law above.

70 High-level expert group on artificial intelligence, Ethics guidelines for trustworthy AI, European Commission, 2019.

understanding is based on four ethical principles: respect for human autonomy – only attributable to human beings and a central aspect of dignity and agency; prevention of harm – avoidance of harmful practices and their aggravation; fairness – ensuring equality and justice, absence of unfair bias, discrimination and stigmatisation; and freedom of choice and proportionality between means and ends and explicability – transparency of processes, open communication of capabilities and purpose and explainable decisions for those directly and indirectly affected.

3.3. Exponential growth of the AI market and the risk of 'delayed' regulatory change

World revenues from the AI market are expected to total US$156.5 billion in 2020.[71] This estimate, from August 2020, which accounts for slower growth due to the coronavirus pandemic, still indicates an increase of 12.3 % compared to the previous year.[72] Global revenues for the AI market are expected to double and surpass US$300 billion by as early as 2024.[73] Customer relationship management (CRM) and enterprise risk management (ERM) AI applications are the two largest segments of the AI market, representing almost 70 % of total AI market revenues.[74]

This data demonstrates that AI systems are already part of business practices, for example, responsible for risk assessment and relationships with customers. The growth projections indicate that AI technology will become increasingly commonplace in all aspects of our daily private and professional lives.[75] Therefore, the expected impact and diffusion of AI, already in the nearest future is likely to be profound, transforming all areas, including for example, law, employment markets[76] and social practices.

3.4. Fragmentation of national actions as a risk to EU global competitiveness and standard setting

Most EU Member States have already adopted or will shortly adopt AI national strategies that among other issues define national approaches on ethics and AI.[77] For example, the 2019 Danish national strategy for artificial intelligence includes six principles for ethical AI including: self-determination, dignity, responsibility, explainability, equality and justice, and development, and provides for the

71 International Data Corporation (IDC), IDC Forecasts Strong 12.3 % Growth for AI Market in 2020 Amidst Challenging Circumstances, 2020.

72 Ibid, IDC 2020.

73 Ibid, IDC 2020.

74 The AI market includes software, hardware and services; ibid. IDC 2020.

75 Vice president of Artificial Intelligence Research at the International Data Corporation explains: 'The role of AI applications in enterprises is rapidly evolving. It is transforming how your customers buy, your suppliers deliver, and your competitors compete. AI applications continue to be at the forefront of digital transformation (DX) initiatives, driving both innovation and improvement to business operations', ibid. IDC 2020.

76 According to the IDC report, IT skills are needed in 90 % of existing jobs but 61 million people do not have adequate basic skills. In the last 10 years, two million jobs were created by digitalisation and in ICT 1.75 million new jobs are expected. The risk of jobs facing automation varies between 14 and 47 %. The error rate of AI is decreasing, as for example in image labelling it is about 2.5 % and thereby two times lower than by humans. The cross-border flow of data is 45 times higher that it was in 2005. The proportion of highly-digitised EU companies is about 20 %; and 85 % of the machine learning workforce is male. For details, see M. Sevoz, The future of work - work of the Future! On how artificial intelligence, robotics and automation are transforming jobs and the economy in Europe, European Commission 2019.

77 In 2018, 29 EU Member States signed a Declaration of Cooperation on AI. For analysis of national initiatives see for instance: The ethics of artificial intelligence: Issues and initiatives, EPRS, European Parliament, 2020.

establishment of a national Data Ethics Council. In France, an initiative 'AI for Humanity' started in 2018. The idea of this initiative to help French talent, enhance the use of data and create an ethical framework on AI.[78] Likewise the 2018 German AI strategy contains three commitments: make the country a global leader in AI, protect and defend responsible AI, and integrate AI in society while following ethical, legal, cultural and institutional provisions.[79]

In the highly competitive global AI landscape,[80] fragmented EU action on the ethics of AI could essentially mean losing a global competitive advantage and building obstacles to the cross-border movement of goods and services in the internal market. Ex-post regulatory efforts to bring joint standards for the EU internal market could potentially have high political and economic costs that could be avoided by taking ex-ante joint regulatory action at EU level.[81] The nature of AI technologies, the AI market structure and the amount of investments necessary for the research, development and uptake of those technologies indicate that the efforts and regulatory actions of individual Member States would be unlikely to achieve the same benefits as joint EU action owing to the scale of their impact. [82] The EU Member States support and are encouraging joint EU action. For example, in its 2019 conclusions on AI, the Council of the European Union emphasised 'the importance of coordinated action in order to maximise the impact of investments made at European, national and regional level, including those supported by the European Investment Bank, in order to increase the competitiveness of European industry at global level' and specifically highlighted the importance of 'making ethics in artificial intelligence a competitive advantage for European industry'.[83]

3.5. Initiatives by global technology-sector corporations as a potential risk to the balanced protection of public interests and to SMEs

On the basis of numerous analyses of the existing mechanisms and initiatives on AI ethics, there is general agreement that there is an increasing realisation that AI technologies can bring tremendous benefits but also be a source of considerable harm. The proliferation of initiatives on ethics by both public and private actors in this respect is a welcome development. However, there is also much cause for concern.

Rességuier and Rodrigues point out that 'ethics developments, while promising, are also problematic: their effectiveness is still to be demonstrated and they are particularly prone to

[78] See the report on AI by Cédric Villani, French mathematician and politician, which includes recommendations looking at economic policy, research infrastructure, employment and ethics as the basis for the initiative.

[79] Other EU Member States have also already adopted or are in course of adopting and planning to establish their own national frameworks on ethics and AI and/or initiatives. These include Sweden, Austria, Estonia, Italy, Malta and Poland.

[80] For an overview of global strategies, see e.g. A. Jobin, M. Ienca, and E. Vayena, 'The global landscape of AI ethics guidelines', *Nature Machine Intelligence*, Vol. 1(9), 2019, pp. 389-399.

[81] See for example developments in the EU relating to the regulation of unmanned aircraft, discussed in T. Evas, Civil liability regime for artificial intelligence: European Added Value Assessment, European Parliamentary Research Service, PE 654.178, September 2020.

[82] See, for example, T. Madiega, EU guidelines on ethics in artificial intelligence: Context and implementation, EPRS, European Parliament, 2019, who argues that in order to avoid incoherence of the harmonisation of EU ethical guidelines and EU actions intending to avoid discrepancies within the EU this will be of essential importance.

[83] Council of the European Union, Artificial intelligence, Conclusions on the coordinated plan for artificial intelligence, 6177/19, from 11 February 2019.

manipulation, especially by industry'.[84] Rodrigo Ochigame, a researcher at the MIT, is even more bold. His recent article analysing the situation in the US argues that 'The discourse of "ethical AI" was aligned strategically with a Silicon Valley effort seeking to avoid legally enforceable restrictions of controversial technologies'.[85] While Ochigame focused his analysis and discussion on the US, the arguments and evidence he presents are not less pertinent to the EU. In describing the position and the mechanisms of influence by large corporate actors of Silicon Valley, Ochigame explains:

> *'To characterize the corporate agenda, it is helpful to distinguish between three kinds of regulatory possibilities for a given technology: (1) no legal regulation at all, leaving "ethical principles" and "responsible practices" as merely voluntary; (2) moderate legal regulation encouraging or requiring technical adjustments that do not conflict significantly with profits; or (3) restrictive legal regulation curbing or banning deployment of the technology. Unsurprisingly, the tech industry tends to support the first two and oppose the last. The corporate-sponsored discourse of "ethical AI" enables precisely this position.'*[86]

Similarly, Hagendorff, focusing on the global AI landscape concludes: 'The close link between business and science is not only revealed by the fact that all of the major AI conferences are sponsored by industry partners. The link between business and science is also well illustrated by the AI Index 2018. Statistics show that, for example, the number of corporate-affiliated AI papers has grown significantly in recent years'.[87]

3.6. Lack of binding norms as a challenge to enforcement and oversight

The lack of binding norms and regulatory oversight is a general policy direction supported by big business. There are, however, numerous accounts, based on the review of business policies and practices and an empirical survey on ethical decision-making of software engineers, that the impact of AI ethics in practice is currently very modest if it exists at all.[88] Hagendorff summarises this as follows: 'Currently, AI ethics is failing in many cases. Ethics lacks a reinforcement mechanism. Deviations from the various codes of ethics have no consequences. And in cases where ethics is integrated into institutions, it mainly serves as a marketing strategy. Furthermore, empirical experiments show that reading ethics guidelines has no significant influence on the decision-making of software developers'.[89]

Similarly pessimistic conclusions on AI ethics in principle and AI ethics in practice arise from a more recent 2019 empirical study by a group of European researchers.[90] This study concludes that developers: 'consider ethics as a construct impractical and distant from the issues they face in their

[84] A. Rességuier, and R. Rodrigues, 'AI ethics should not remain toothless! A call to bring back the teeth of ethics', *Big Data & Society*, Vol. 7(2), 2020.

[85] R. Ochigame, The invention of 'ethical AI': how big tech manipulates academia to avoid regulation, The Intercept, 2019.

[86] R. Ochigame, The invention of 'ethical AI': how big tech manipulates academia to avoid regulation, The Intercept, 2019.

[87] T. Hagendorff, 'The ethics of AI ethics: An evaluation of guidelines', *Minds and Machines*, 2020, pp. 1-22.

[88] A. McNamara, J. Smith, and E. Murphy-Hill, Does ACM's code of ethics change ethical decision making in software development?, In Proceedings of the 2018 26th ACM Joint Meeting on European Software Engineering Conference and Symposium on the Foundations of Software Engineering, 2018, pp. 729-733.

[89] T. Hagendorff, 'The ethics of AI ethics: An evaluation of guidelines', *Minds and Machines*, 2020, pp. 1-22.

[90] V. Vakkuri, K.-K. Kemell, J. Kultanen, M. Siponen and P. Abrahamsson, Ethically aligned design of autonomous systems: Industry viewpoint and an empirical study, 2019.

work. […] While various guidelines for AI ethics currently exist, written by both practitioners and scholars alike, these guidelines are not used by industry experts'.[91]

Overall, scholars increasingly agree that a current tendency to (ab)use ethics to prevent legally enforceable regulation is a significant problem and an alarming abuse of ethics, which leads to worrying practices such as 'ethics washing', 'ethics shopping' and 'ethics shrinking' among others.[92]

91 V. Vakkuri, K.-K. Kemell, J. Kultanen, M. Siponen, and P. Abrahamsson, Ethically aligned design of autonomous systems: Industry viewpoint and an empirical study, 2019.

92 See, for example, L. Floridi, 'Translating principles into practices of digital ethics: Five risks of being unethical', *Philosophy & Technology*, Vol. 32(2), 2019, pp.185-193.

4. Possible EU policy responses to the current challenges

Based on the analysis of the existing risks and challenges, this chapter focuses on an assessment of the need to address those challenges at EU level. The chapter discusses seven main reasons that common action at EU level has the potential to generate greater added value than the actions of individual Member States. The chapter begins with a discussion of the possible legal basis for taking EU-level action.

4.1. Legal basis and principle of subsidiarity

The legal basis for EU action on ethical principles for the development, deployment and use of artificial intelligence, robotics and related technologies can be Article 114 of the TFEU.

Article 26(1) TFEU empowers the EU to 'adopt measures with the aim of establishing or ensuring the functioning of the internal market, in accordance with the relevant provisions of the Treaties'. In particular, Article 114 TFEU states that following the ordinary legislative procedure and after consulting the European Economic and Social Committee, the EU legislature can adopt 'measures for the approximation of the provisions laid down by law, regulation or administrative action in Member States which have as their object the establishment and functioning of the internal market'. According to Article 4 (2) a), the internal market is a 'shared competence'. Article 5(3) TEU states that in the area of shared competence, in order to uphold the principle of subsidiarity, the Union should act 'only if and in so far as the objectives of the proposed action cannot be sufficiently achieved by the Member States, either at central level or at regional and local level, but can rather, by reason of the scale or effects of the proposed action, be better achieved at Union level'.

The case law of the Court of Justice of the European Union recently re-confirmed that the EU legislature may adopt measures on the basis of Article 114 'where there are differences between national rules which are such as to obstruct the obstruct the fundamental freedoms and thus have a direct effect on the functioning of the internal market or to cause significant distortions of competition'.[93] EU action on the basis of Article 114 can be taken to address already existing obstacles to prevent the emergence of such obstacles resulting from divergent national laws.[94] The Court of Justice has recognised, for example, that heterogeneous application of technical requirements could be valid grounds for recourse to Article 114 TFEU.[95]

Article 114 TFEU as a legal basis for EU action on robotics and AI was also suggested by the European Parliament in its 2017 resolution on civil law rules on robotics. The explanatory statement to the draft resolution stated:

> *'The action by the Commission in order to adapt the existing legislation to the reality of robots and artificial intelligence should be based on Article 114 TFEU. […] The development of robotics is currently happening in the entire Union. In reaction to this innovation, Member States are developing different national legislations. These discrepancies are expected to create obstacles for an effective development of robotics. Due to the fact that this technology has cross-border implications, the best legislative option is a European one.'*[96]

93 Case C-398/13 P, *Inuit Tapiriit Kanatami and Others* v *European Commission*, para. 26.

94 Case C-482/17, *Czech Republic* v *European Parliament and Council of the European Union*, para. 35.

95 Case C-217/04, *United Kingdom of Great Britain and Northern Ireland* v *European Parliament and Council of the European Union*, paras. 62-63

96 Explanatory Statement to the draft report with recommendations to the Commission on Civil Law Rules on Robotics (2015/2103(INL)) of Committee on Legal Affairs, p.21.

4.2. Necessity to act

Chapter 3 discussed the main existing challenges and risks that emerge from the current regulatory framework. Those challenges can be best addressed by taking EU action to establish a legal framework of ethical principles for the development, deployment and use of artificial intelligence, robotics and related technologies.

4.2.1. Static nature of the regulatory framework and the need for an 'ex-ante' dynamic approach – EU action as a tool for regulatory innovation and protection against fragmentation of the internal market

The SIENNA project, discussed above, analysed national law and national academic legal discourse on AI and robotics in the EU Member States. The report underlines that ongoing discussions on AI in the EU have facilitated the adoption of national strategies on AI in most of the Member States. However, the report stresses that the current intensity of both policy and legal academic discussion in the Member States differs considerably. Some Member States, among others, France and Germany, have invested substantial effort in discussing possible regulatory approaches to the challenges of AI across a diverse spectrum of policy areas. Other Member States, are much further behind and in some debates are just emerging. A new coherent EU-level framework on ethics of AI would create a level playing field for all EU market players.

As many publications acknowledge, the challenges triggered by AI are very complex and there are no ready-made solutions. The discussions in the AI HLEG, have shown how difficult it is to discuss and achieve a common understanding on the central issues relating to the AI ethics debate. However, the same debate also has indicated that EU-wide regulation could facilitate strategic planning and public regulatory innovation significantly across the EU (consider the adoption of national AI strategies facilitated by this process).

Accordingly, legislative action at EU level, if based on proper consultation of a wide range of stakeholders across the EU, could be a helpful tool when it comes to facilitating the debate and contributing to innovation in national regulatory approaches across the EU. Cross-border regulatory facilitation of national discussions is particularly necessary in areas as complex and dynamic as AI. An EU framework and its subsequent implementation in the EU Member States has strong potential to be an important regulatory tool to facilitate the overall upward movement in terms of innovation of regulatory approaches across all EU Member States and to ensure that individuals across the EU internal market benefit from protection of their fundamental rights and freedoms on a comparable level.

4.2.2. Lack of a common definition and fragmentation of national action – EU action as a tool for global competitiveness and accountable leadership

The absence of a common definition is considered to be one of the obstacles to developing an effective AI ethics policy. The EU is already lagging behind in its research and development of AI as compared to other global actors such as the US and China, and corporate actors in the field. However, the EU as one of the biggest economic markets and a strong regulatory powerhouse, can still set global standards and derive benefits by becoming 'a first mover' in regulating AI ethics. In this context, the common EU regulatory action on AI ethics could be the 'so-called silver bullet in the EU's strategy to 'catch up' with the USA or China'.[97]

[97] R. Csernatoni, An Ambitious Agenda or Big Words? Developing a European Approach to AI, 2019.

The timely and effective adoption and implementation of the GDPR is a key recent example of how the EU, acting as a regional block, can successfully build a global strategic advantage.[98] Recent studies analysing the key success factors of the GDPR conclude that EU's success as a global standard setter on data privacy and protection was due to its 'first mover advantage', democratic legitimacy, transparency, and market size.[99] In the area of AI ethics, the EU again has an opportunity to seize the 'Brussels effect' by utilising current regulatory governance uncertainty and the absence of a competing model on regulation of AI ethics. Combined with its market and regulatory power, as well as its strong stance on protection of fundamental rights, the EU is well-placed to build a Magna Carta of AI ethics that could match the global success of the GDPR.

4.2.3. Risk of 'corporate capture' – EU action as a tool to protect public interest and enhance the social responsibility of global corporate actors

Large corporate multinational companies are actively present in the global AI ethics debate. The review of global AI ethics guidelines suggests that almost half the existing guidelines have been issued by the private sector.[100] This in itself is not a problem, unless corporate influence leads to an imbalance between public interest and the business interests of just a few corporations.

In this context, the qualitative in-depth analysis of the global initiatives adopted on AI ethics is very instructive. Jobin et al. provide an interesting, empirically based assessment of references to the concept of 'trust', one of the ethical issues most commonly referred to. This analysis suggests that while both public and private initiatives refer to 'trust', the discourse and the function of the reference to trust is different.[101]

The growing influence of large and multinational corporations in the technology sector on the AI ethics debate is well documented.[102] This poses a serious risk to the protection of public interests (which public institutions should protect) runs the risk of disenfranchising small and medium-sized enterprises from AI debates. The concentration of power among a few large corporations, which are currently attempting to shape AI discourse and policy to their advantage, risks leading to an imbalance of power, to the degree that the action of individual public actors would be 'captured'. This could potentially be especially problematic for smaller Member States or smaller companies that do not have sufficient resources and mechanisms to withstand this pressure.

The EU as a collective actor has significantly greater power and influence to protect the public interest of EU citizens and SMEs than the individual action of any EU Member State alone. The scale of the EU matters, in terms of both its market size and its regulatory power. As experience in other policy areas shows (consider for example competition law or protection of personal data), joint EU action to protect the public interests of consumers and prevent the abuse of power, could be

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98 On the global impact of the GDPR, see H. Li, L. Yu, and W. He, 'The impact of GDPR on global technology development', *Journal of Global Information Technology Management*, Vol. 22, 2019, pp.1-6; T. Linden et al., The privacy policy landscape after the GDPR, Proceedings on Privacy Enhancing Technologies, 2020, pp. 47-64.

99 See E. Pernot-Leplay, 'EU Influence on Data Privacy Laws: Is the US Approach Converging with the EU Model?', *Colorado Technology Law Journal*, Vol.18(1), 2020; E. Brattberg, R. Csernatoni and V. Rugova, Europe and AI: Leading, Lagging Behind, or Carving Its Own Way?, Carnegie Endowment for International Peace, 2020.

100 A. Jobin, M. Ienca, and E. Vayena, 'The global landscape of AI ethics guidelines', *Nature Machine Intelligence* Vol. 1(9), 2019, pp. 389-399.

101 Ibid. Jobbin et al.p.396, suggest that push of private actors to build 'trust in AI risks diminishing scrutiny and may undermine certain societal obligations of AI producers'.

102 See Chapter 3 above.

effective even against large multinational corporations and bring tangible results that would otherwise be difficult to achieve.

4.2.4. Self-regulation and weak enforceability – EU action as an accountability tool to guarantee effective measures to protect fundamental EU values

Joint EU action on AI ethics could also provide a powerful shield to secure effective consumer and fundamental rights protection. Daniel Schiff et al in their recent publications providing a global overview of 80 AI ethics policy documents and guidelines, focused specifically on the analysis of factors that predict the success of a policy measure.[103] The success of a policy document was assessed in terms of its global impact on AI ethics governance and the ability of the documents to facilitate achievement of their stated goals. Based on this assessment, Schiff et al identify five main factors of success: engagement, specificity, reach, iteration and follow-up, and enforceability and monitoring.[104]

The 'soft' nature of AI, specifically the lack of enforceability and monitoring, is a growing area of concern.[105] This concern, shared by an increasing number of scholars, is proven by an expanding volume of empirical research that suggests that lack of enforceability is a serious risk and a factor contributing to the violation of ethical codes. Brent Mittelstadt argues convincingly that 'without complementary punitive mechanisms and governance bodies to "step in" when self-governance fails, a principled approach runs the risk of merely providing false assurances of ethical or trustworthy AI'.[106]

The lack of enforcement of AI ethics principles could be a serious threat to the credibility of any governance instrument and ultimately have a negative impact on the trust of users and consumers in AI technologies. Once again, the example of the GDPR is instructive. Enhancing individuals' rights to data protection with a strong independent supervisory mechanism that facilitates the enforcement and promotion of rules was key to the GDPR's success. Therefore, EU joint action has the potential to be an important step in the shift from voluntary, self-regulatory codes of ethics on AI, to a legally binding, enforceable mechanism that would ensure the protection of fundamental values at all stages of development and application of AI. This would facilitate the mainstreaming of ethical values in all stages of the value chain and provide the necessary 'teeth' for AI ethics.

EU policy action would also be in line with the expectation of the majority of Europeans. The results of the 2019 Eurobarometer suggest that 51 % of Europeans consider public intervention necessary to ensure the ethical development of AI.[107] Support for public intervention is especially high in the Netherlands (77 %) and Sweden (72 %) and lowest in Romania (19 %).[108]

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[103] D. Schiff, J. Biddle, J. Borenstein and K. Laas, What's Next for AI Ethics, Policy, and Governance? A Global Overview, In Proceedings of the AAAI/ACM Conference on AI, Ethics, and Society, 2020, pp. 153-158.

[104] 'Engagement' refers to the governance framework that embeds the AI ethics policy into major international standards. 'Specificity' concerns the level of detail. 'Reach' relates to the scope. 'Iteration and follow-up' refers to the 'living' nature of the document and its ability to adjust.

[105] For an analysis of self-regulation as a governance approach and its limitations, see R. Clarke, 'Regulatory alternatives for AI', *Computer Law & Security Review*, Vol. 35 (4), 2019, pp. 398-409.

[106] B. Mittelstadt, 'Principles Alone Cannot Guarantee Ethical AI', *Nature Machine Intelligence,* 2019, pp. 501-507.

[107] Standard Eurobarometer 92: Report Europeans and Artificial Intelligence, European Commission, 2019.

[108] The divergence between Member States in terms of support requires further research in conjunction with data on awareness and understanding of the ethical and fundamental rights discourse in the context of AI.

4.3. Policy options and their impacts

The aim of this EAVA is to assess the socio-economic impacts of joint EU action on an ethical framework for AI. Accordingly, two policy options with a focus on joint action have been analysed. The assessment is based on a comparison of the two policy options against a baseline scenario reflecting the current status quo.

- Policy option 0: **baseline scenario** – reflecting the status quo with no additional action at EU level
- Policy option 1: a **unified approach** with highly harmonised European legislation
- Policy option 2: a **coordinated approach** with a coordinated governance approach at EU level and joint responsibility sharing between EU and national levels.[109]

Both policy options 1 and 2 presuppose joint EU action. The main difference between policy option 1 and policy option 2 is the regulatory approach to joint EU action. Policy option 1 puts the main emphasis on a common (uniform) regulatory approach. Policy option 2 is based on joint coordinated governance to ensure the consistency of approaches to the ethical framework across the Member States, leaving national policy actions a degree of flexibility.

[109] Please note that the annexed research paper by Ecorys refers to policy option 1 as a 'common approach'. The 'common approach' as discussed in the research paper in essence calls for a high degree of harmonisation and unification of norms, this is why, to avoid confusion, this EAVA suggests referring to it as a 'unified approach'. The Delfi-method expert survey used for the input into the CGE model was based on the definitions as provided in the research paper.

5. European added value

The assessment of the added value indicates that substantial socio-economic value can be potentially generated through joint EU action. [110] This EAV assessment focuses on the net impacts on the European economy and society in terms of GDP and employment that could result from joint EU action.[111]

5.1. Quantitative assessment of the policy options

The results of the quantitative assessment of the policy options indicate that joint EU action on the ethical aspects of artificial intelligence, robotics and related technologies would provide net benefits in terms of real GDP, private consumption, employment and capital stocks compared to the baseline scenario. Therefore, both policy options would lead to additional economic growth and generate European added value.

Table 2 – Impact on selected macroeconomic variables by 2030 of implementing policy options 1 and 2 (percentage deviations from baseline scenario values)

Variable	Policy option 1	Policy option 2
Real GDP	1.4	1.9
Private consumption	1.8	2.6
Employment	1.6	2.2
Capital stocks	0.7	0.9

Source: Author, based on the annexed research paper on the European added value of a framework of ethical aspects of artificial intelligence, robotics and related technologies, Table 7.

The magnitude of impacts, in terms of net benefits as compared to the baseline scenario, grows over time; however the positive impacts, albeit at first modest, would be already present shortly after adoption of an EU action. If EU joint action were to be taken now, within five years it would have the potential to generate between €182 and 244.5 billion in additional GDP and 3.2 to 4.3 million additional jobs. In a 10-year perspective, the net benefit would be in the range of €221.8 to 294.9 billion in additional GDP and 3.3 to 4.6 million additional jobs.

[110] EPRS commissioned an external study by Ecorys Consultancy to quantitatively assess the possible added value of a European framework of ethical aspects of AI, robotics and related technologies. The results of the research paper commissioned are presented in annex.

[111] This EAVA and the research paper on the quantitative assessment by Ecorys did not engage with putting an economic value on ethics, per se, but rather attempted to estimate and quantify to the extent possible the impacts on the EU economy that could be generated as a result of EU action.

Table 3 – Summary of estimated benefits for GDP and employment (in absolute numbers for 2025 and 2030)

Year	Policy option 1	Policy option 2
2025	€182 billion additional in GDP and 3.2 million additional jobs	€244.5 billion in additional GDP and 4.3 million additional jobs
2030	€221.8 billion in additional GDP and 3.3 million additional jobs	€294.9 billion in additional GDP and 4.6 million additional jobs
Increasing social acceptance	medium	high

Source: Annex, Research paper on the European added value of a framework of ethical aspects of artificial intelligence, robotics and related technologies.

The EU joint action would have a positive impact on all economic sectors albeit to different degrees. In terms of sectoral impacts, measured in terms of percentage deviation from a baseline scenario, it has been estimated that EU action on ethical aspects in a 10-year horizon (2030) will have the largest impact on the 'arts, entertainment and recreation' economic sector, which will in terms of real value added generate an additional 2 % under PO 1 and 3.3 % under PO 2 as compared to the baseline; this is followed by 'financial and insurance activities' (+1.8 % (PO 1) and +2.5 % (PO 2)); wholesale and retail trade, transport, accommodation and food services activities (+1.6 % (PO 1) and 2.9 % (PO 2)). The smallest, but still, net positive impact is estimated for 'public administration, defence, education, human health and social work activities' (+0.6 % (PO 1) and +0.7 % (PO 2). In terms of total factor productivity, it is estimated that joint EU action would have the largest net positive benefit on industry as an economic sector ((+0.58 % (PO 1) and +0.7 % (PO 2)). The construction sector would benefit most in terms of employment (+4.9 % (PO 1) and +9.3 % (PO 2));

Table 4 – Summary estimated benefits per economic sector in 2030 (as a % deviation from the baseline)

Economic Sector	Real value added		Total factor productivity		Employment	
	PO 1	PO 2	PO 1	PO 2	PO 1	PO 2
Agriculture, forestry and fishing	1.5	2.3	0.32	0.55	3.9	6.8
Industry (except construction and manufacturing)	1.6	1.9	**0.58**	**0.70**	3.0	3.4
Manufacturing	1.3	1.0	0.21	0.42	1.7	0.8
Construction	1.0	2.4	0.36	0.51	**4.9**	**9.3**
Wholesale and retail trade, transport, accommodation and food service activities	1.6	2.9	0.42	0.42	3.6	5.6
Information and communication	1.1	1.2	0.29	0.37	0.9	0.7
Financial and insurance activities	1.8	2.5	0.35	0.47	2.4	3.4
Real estate activities	1.6	1.6	0.32	0.51	1.7	2.4
Professional, scientific and technical activities; administrative and support service activities	1.3	1.4	0.44	0.60	0.9	1.5

Public administration, defence, education, human health and social work activities	0.6	0.7	0.39	0.56	1.9	1.4
Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies	**2.0**	**3.3**	0.32	0.44	1.4	1.2

Source: Annex, Research paper on the European added value of a framework of ethical aspects of artificial intelligence, robotics and related technologies.

It is estimated that in a 10-year horizon (2030), joint EU action will have the largest impact in terms of GDP in absolute numbers on the 'wholesale and retail trade, transport, accommodation and food service activities' economic sector bringing an additional €86 billion in real GDP value added under PO 2. The largest impact on employment, measured in terms of net positive number of jobs created in the economic sector is also in the 'wholesale and retail trade, transport, accommodation and food service activities' sector, where it is estimated that 1.68 million jobs would be added.

Table 5 – Summary of estimated benefits per economic sector in 2030 (in absolute numbers)

Economic Sector	Real value added		Employment	
	PO 1	PO 2	PO 1	PO 2
Agriculture, forestry and fishing	€3.9 billion	€5.9 billion	0.24 million	0.33 million
Industry (except construction and manufacturing)	€7.3 billion	€9 billion	0.06 million	0.09 million
Manufacturing	€34.5 billion	€27.6 billion	0.33 million	0.46 million
Construction	€7.8 billion	€19.3 billion	0.43 million	0.59 million
Wholesale and retail trade, transport, accommodation and food service activities	€48.6 billion	€86 billion	1.22 million	1.68 million
Information and communication	€8.9 billion	€9.9 billion	0.04 million	0.05 million
Financial and insurance activities	€13.6 billion	€19 billion	0.07 million	0.1 million
Real estate activities	€25.6 billion	€27.2 billion	0.02 million	0.03 million
Professional, scientific and technical activities; administrative and support service activities	€21.5 billion	€24 billion	0.16 million	0.22 million
Public administration, defence, education, human health and social work activities	€16.7 billion	€18.6 billion	0.61 million	0.85 million
Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies	€10 billion	€17 billion	0.12 million	0.16 million

*Real added value in € billion (equals 1 000 million) constant 2019 prices; total factor productivity as percentage deviations from the baseline scenario values; employment in millions of people.

Source: Author, based on Research paper (annexed to this study) on the European added value of a framework of ethical aspects of artificial intelligence, robotics and related technologies, Tables 10, 12-14, 16 and 18.

5.2. Qualitative assessment of policy options

Any economic model is a simplification of reality that cannot fully capture the qualitative impacts on social and fundamental rights and values or coherence of the legal system. The quantitative assessment is complimented by a qualitative analysis of the impacts of EU joint action that are not monetised in the quantitative assessment. For the comparative analysis, five groups of impacts were been assessed qualitatively.[112]

- Increase in social acceptance of the technology
- Further emphasis of a niche for European competitiveness in a global marketplace
- Easier access to pan-European datasets across the EU for developers of AI applications
- Legal certainty for European AI developers and users
- Projection of European values across the Member States and internationally

The results of the comparative analysis of the three policy options are summed up in Table 6 below.

Table 6 – Comparative qualitative assessment of policy options

EU added value	SQ	PO 1	PO 2	Discussion points based on the expert survey
Increasing social acceptance	-	++	+++	The EU plays an important role in increasing social acceptance. PO 2 was quantitatively seen to have the highest impact and qualitatively, as well. Experts' answers indicated that a more localised approach, taking into account local sensitivities and beliefs might be the reason for this preference.
Emphasising a competitive niche	+	+++	++	Based on the existing understanding, it is expected that a legal framework for ethics in AI will impact the shape of the market, could promote new business models and could potentially influence the need to meet the ethical standards set within European boundaries. A unified approach built on the digital single market would likely have a higher impact.
Facilitating pan-European datasets	0	+	0	A consistent ethical framework will remove some barriers owing to inconsistencies across Member States, but when it comes to data in the digital single market there are many other obstacles than data protection and privacy or other ethical issues. Accordingly, it is anticipated that an ethical framework will have only a minor impact. Still, the impact will be larger under PO 1.
Providing legal certainty	--	++	+	A consistent legal framework across Member States will make it easier for both developers and users to operate with legal certainty. Differing legal standards across the EU on ethical considerations would make it more difficult for European companies to understand what standards they should adhere to so that they can operate easily within the entire digital single market, which is better addressed by PO 1.
Projecting EU values	0	+++	++	There is some evidence that new standards being created by European legislators are influencing jurisdictions outside Europe. PO 1, with a more unified view, would likely increase that impact.

Source: Author, based on the research paper in annex to this study.

[112] Those criteria and the identified impact are based on the results of interviews of experts run as part of the Delphi method by Ecorys. The methodology for the selection and the results are presented in the research paper in annex.

5.3. Comparison of the policy options

The key overall conclusion of the EAVA is that joint EU action on ethical aspects of artificial intelligence, robotics and related technologies is clearly a preferred option as compared to the status quo. This key finding is supported by both a quantitative assessment of possible economic impacts in terms of GDP and employment and a qualitative assessment based on five qualitative criteria.

In terms of a preferred policy option for taking a joint EU action, the preliminary results of this EAVA suggest that PO 2 coordinated action is a preferred option. This result is largely driven by the inputs into the quantitative model based on interviews with experts. It seems that the experts surveyed would prefer a coordinated approach as compared to more intrusive, unified harmonisation measures under PO 1. This finding, in general, reflects the current governance framework on AI ethics, which tends to be lenient toward 'soft' law governance approaches and overall emphasises the complexity of regulating the fundamental values that possibly could inform the EU response. Further additional research, taking into consideration larger datasets, a broader set of stakeholders, more detailed legal feasibility analysis of policy options, and market dynamics is necessary to provide a more nuanced assessment of the relative comparative risks and benefits of PO 1 and PO 2.

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6. Conclusions

The results of this European added value assessment suggest that joint EU regulatory action on ethical aspects of artificial intelligence, robotics and related technologies could generate significant European added value.

An analysis of the current regulatory framework indicates that there is no legally binding, horizontal, legal instrument that specifically establishes a regulatory framework for AI ethics at either EU or global level. Chapter 2 provides an analysis of the European regulatory framework for AI, including an overview of EU primary and secondary law. This analysis suggest that EU primary law, especially the Charter of Fundamental Rights of the EU, provides a solid foundation for the development of possible regulatory action on AI ethics. The emerging secondary law, especially in the area of personal data protection, product safety and liability, and digital single market-related legislation, contributes to the development of fundamental values and principles that are essential for the EU ethics framework. However, this current EU legal and policy framework is not sufficient.

The key gaps and challenges of the emerging regulatory framework and policy context on AI ethics are analysed in Chapter 3. Based on a review of the literature, the EAVA identifies six main gaps and risks. First, the current static regulatory framework could potentially create a risk for the application to dynamic AI systems and place restrictions on ethics. There are, broadly speaking, two sets of inter-related challenges faced by legal systems: 'adaptation', i.e. existing legal principles need to be adjusted and applied, and 'anticipation', i.e. existing legal systems need to be able to provide dynamic legal mechanisms to safeguard from and redress externalities that could potentially emerge owing to the new risks. The second challenge is the absence of a common understanding and definition of AI. This creates obstacles for further action at EU level. Third, the challenge is a growing mismatch between the exponential growth of the AI market and a 'delayed' regulatory response. Fourth, fragmented national actions from Member States could potentially create risks for the internal market and undermine the global competitiveness of the EU. Fifth, accelerating AI ethics initiatives by global corporations in the technology sector pose a potential risk to the balanced protection of public interests and could potentially undermine SME competitiveness. Finally, the current framework characterised by 'soft' initiatives on AI ethics, has a negative impact on compliance, enforcement and oversight.

Article 114 TFEU provides a legal basis to take legislative action on AI ethics in order to prevent potential fragmentation and the externalities of harm created by AI. The necessity and benefits of joint EU action, discussed in Chapter 4, indicate that the current lack of a legally binding framework on AI ethics creates challenges but also significant strategic opportunities for the EU. Ex-ante dynamic regulatory joint action on AI ethics, if adopted, has the potential to become (1) a successful regulatory tool for innovation and protection against fragmentation of the internal market; (2) a means of boosting EU global competitiveness and accountable leadership; (3) a powerful intervention against a growing risk of 'corporate capture' and hence, an instrument to protect public interest and enhance the social responsibility of global corporate actors; and (4) a missing accountability tool to guarantee effective protection of fundamental values in the EU.

The results of qualitative and quantitative assessment of European added value in Chapter 5 suggest that substantial added value could be generated as a result of joint EU action. Three policy options were analysed in order to make a comparative analysis potential impacts. Policy option 0 (PO 0) – the status quo or baseline scenario; policy option 1 (PO 1) – 'uniform' EU common action, entailing a high degree of harmonisation at EU level, and policy option 2 (PO 2) – 'coordinated' EU action driven by joint responsibility between EU and national levels. In terms of the monetised impact for the EU economy, joint EU action, both PO 1 and PO 2, would benefit all sectors of the EU economy as compared to PO 0, the status quo. The magnitude of the impacts, in terms of net benefits as compared to the baseline scenario, grow over time; however the positive impacts would be already present shortly after adoption of an EU action. **Were EU joint action to be taken now, it would have the potential to generate between €182 and 244.5 billion additional GDP and 3.2 to 4.3 million additional jobs within five years. In a 10-year perspective, the net benefit would be in the range of €221.8 to 294.9 billion in additional GDP and 3.3 to 4.6 million additional jobs.**

Joint EU action on AI ethics would benefit all sectors of the EU economy. The greatest net positive benefit as a percentage of deviation from the baseline scenario (by 2030) was estimated to be generated in the 'arts, entertainment and recreation' sector, in terms of additional GDP; in industry, in terms of total factor productivity, and in the construction sector, in terms of employment. Considering the size of the EU's economic sectors, the largest impact in absolute numbers is estimated to be generated in the 'wholesale and retail trade, transport, accommodation and food service activities' sector, bringing an additional €86 billion in real GDP value added and 1.68 million additional jobs to this sector. In terms of a preferred policy option for taking joint EU action, the very preliminary results of this EAVA suggest that coordinated action is the option preferred by experts over more intrusive unified harmonisation measures. **The main underlying conclusion as indicated by both quantitative and qualitative assessments, is that joint EU action is clearly to be preferred as a policy option over the current status quo.**

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Annex

Framework on ethical aspects of artificial intelligence, robotics and related technologies

Research paper

The European Union, through legislation such as the General Data Protection Regulation, has looked to implement new rules for the digital economy that protect citizens fundamental rights and meets both existing and emerging ethical standards. While many studies have examined the social implications of legislation designed to protect rights in emerging domains such as artificial intelligence and robotics, few have considered the economic implications of an ethical framework. While some researchers and practitioners argue that legislation designed to protect citizens have an economic cost, this study demonstrates that an ethical framework for artificial intelligence – by helping to further social acceptance of new technologies and providing other benefits – not only helps maintain ethical standards, but also creates net economic benefits. By 2030, an ethical legislative framework for artificial intelligence and robotics could create between 3.3-4.6 million jobs and add €221-299 billion to the European economy.

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Executive summary

While debate continues within the High-Level Expert Group on Artificial Intelligence (AI HLEG) on how to define ethical standards for artificial intelligence – through their initiative on trustworthy AI – a legal framework already exists which covers some element of the ethics and values that Europeans hold dear. The reason to implement an ethical framework is both to ensure transparency so that new applications follow the same ethical standards as existing methods and to protect new 'emerging' rights that have been created by the digital economy. The best example of an emerging ethical consideration is over data privacy, which has become a right in and of itself, rather than a component of some other right. The EU Charter, through Article 8, makes clear that the European Union considers the protection of personal data is an independent right.

Within this context, the AI HLEG developed four ethical principles that are also ethical imperatives that they argue should be respected in the development, deployment and use of AI:

1. Respect for human autonomy: From an ethical perspective, autonomy is a quality that can be only attributed to human beings. It is expressed in the human abilities to be self-aware, self-conscious and a self-author, meaning being able to set own rules and standards and choose own goals and purposes in life. Autonomy is a central aspect of human dignity and agency.
2. Prevention of harm: The second principle addresses directly both physical and mental well-being of people interacting with artificial intelligence systems. Importantly, vulnerable people should be included in development deployment and use of AI, and that impacts of AI studied to ensure that they are not creating or exacerbating harmful practices.
3. Fairness: Fairness involves both process and substance. Fairness means ensuring equal and just distribution of benefits and costs, freedom from unfair bias, discrimination and stigmatisation, freedom of choice and respect of proportionality between means and ends. It also entails the ability to contest and seek effective redress against decision made by AI and humans operating them. Accountability of AI operators and explicability of AI decisions are crucial for this principle.
4. Explicability: The final principle follows directly from the principle of human autonomy as it is a part of human agency to be able and willing to take and attribute moral responsibility (i.e. causality, accountability and liability).

While the European Union has made good progress to understand on how to define an ethical standard for artificial intelligence, open questions remain on the value of Europe in this debate. Importantly, what has also been missing in this debate has been an attempt to quantify the impact of an ethical framework for artificial intelligence will have on the broader EU economy. This assessment of European added value aims to fill both of those gaps.

To conduct the analysis, the study relied on wide-ranging expert input to create an estimate of the impact of an ethical framework based on the definition from the AI HLEG. The analysis focussed on a diverse set of sectors that represented a large component of the economy and that would face varied impacts from an ethical framework. The sectors under consideration were the transport sector, health care, human health and social work, construction, and financial services.

The European added value of various EU policy options of ethical aspects of AI, robotics and related technologies were assessed quantitatively by using a computable general equilibrium (CGE) model. By using such a model, the study quantified the macro-economic impacts of the two developed policy options and status quo or baseline.

The two scenarios of policy options were developed to reflect the potential legislative or regulatory actions in relation to the ethical use of artificial intelligence, robotics and related technologies. The developed options served as an input into the CGE model assessing the European added value of policy options for ethical AI. The developed scenarios are compared to the status quo or no action situation: Common and Coordinated approached.

Scenario 1: Common approach

A EU-level regulation is introduced requesting to ensure that the development, deployment and use of AI, robotics and related technologies complies with the ethical framework as developed by the HLEG-AI. This means that AI applications must respect human autonomy, prevent harm, and ensure fairness.[1] Developers and providers should:

1. Acknowledge and address the potential tensions between these three principles;
2. Pay particular attention to vulnerable groups, such as children, persons with disabilities, or others that have historically been excluded or discriminated against;
3. Also pay attention to power or information imbalances, such as between employers and workers, or between businesses and consumers;
4. Acknowledge that, while bringing substantial benefits to individuals and society, AI systems also pose risks, including difficult-to-anticipate impacts (e.g. on democracy, the rule of law and distributive justice, or on the human mind itself.

As such, Europe may look to create a framework that would mitigate these risks. These principles can be made operational through a number of methods outlined by the HLEG-AI, including (but not exclusive to):

- 'Human oversight' through governance mechanisms, such as a human-in-the-loop (HITL), human-on-the-loop (HOTL), or human-in-command (HIC) principles;
- Audits of AI system, both at development and deployment phases; and
- Privacy and data protection via cybersecurity certification, which should take place throughout a system's entire lifecycle.

Scenario 2: Coordinated approach

At the EU level, a framework (directive) of ethical principles is introduced for the development, deployment and use of AI, robotics and related technologies as described in scenario 1 'Common approach'.

However, Member States will need to implement these principles through their legislation and can go over and above the minimum requirements. No new governance structures are created at the EU level. Member States are free to adjust their national governance structures as they deem fit.

What the results of the study has made clear is that Europe has an important and positive policy role to play in creating an ethical framework. Importantly, a well-implemented framework will not only have a positive impact on the rights that Europeans enjoy, but it will also lead to additional economic growth. One point of contention in the debate over ethical artificial intelligence is that creating a regulatory framework will impede European industry looking to develop new and innovation solutions. These same concerns have been raised in regard to the General Data Protection Regulation (GDPR), though few studies exist to substantiate the claims that the GDPR creates a significant economic negative to the European economy, as mentioned earlier in this

[1] Developers and providers should: (1) Acknowledge and address the potential tensions between these three principles; (2) Pay particular attention to vulnerable groups, such as children, persons with disabilities, or others that have historically been excluded or discriminated against; (3) Also pay attention to power or information imbalances, such as between employers and workers, or between businesses and consumers; (4) Acknowledge that, while bringing substantial benefits to individuals and society, AI systems also pose risks, including difficult-to-anticipate impacts (e.g. on democracy, the rule of law and distributive justice, or on the human mind itself.

report. In fact, the evidence presented in this report suggests that this narrative is false. An ethical framework would provide a net benefit, both from an economic perspective as well as for some of the 'softer' added value, such as projecting European values globally.

The following table summarises the overall net benefit to the EU economy of a framework for AI in both scenarios:

Table 1: Impact of implementing policy options 1 and 2 on selected macroeconomic variables (absolute deviations from baseline scenario values)

	GDP		Employment	
	Policy option 1	**Policy option 2**	**Policy option 1**	**Policy option 2**
2020	24 400	32 575	488 000	646 000
2021	53 014	71 147	1 012 000	1 358 000
2022	82 400	110 658	1 535 000	2 072 000
2023	113 695	152 673	2 071 000	2 806 000
2024	146 917	197 264	2 622 000	3 563 000
2025	182 094	244 516	3 188 000	4 343 000
2026	191 028	255 845	3 212 000	4 388 000
2027	199 469	266 554	3 235 000	4 432 000
2028	207 407	276 628	3 258 000	4 476 000
2029	214 835	286 057	3 281 000	4 518 000
2030	221 754	294 839	3 303 000	4 559 000

Note: GDP figures reported at constant 2019 prices in millions of euros.

Table 2: Qualitative level of impact of policy options per EU added value

EU Added value	Status quo	Scenario 1	Scenario 2	Discussion points
Increasing social acceptance	-	++	+++	As noted in the survey for this assignment, many experts and practitioners that we approached believed that the EU played an important role in increasing social acceptance. Quantitatively, scenario 2 was seen to have the highest impact. A more localised approach, which can take into account local sensitivities and beliefs, can help to explain why impacts of scenario 2 are seen to be higher than scenario 1.
Emphasising a competitive niche	+	+++	++	Given that European legislation around the ethics of artificial intelligence and data are in early stages, researchers are still collecting data to measure the impacts. It is expected, however, that these frameworks will impact the shape of the market and – depending on the specificity of the provisions – can promote new business models and potentially influence not meeting ethical standards from operating within European boundaries. A unified

				approach build off of the digital single market would likely have a higher impact, but both policy options present benefits.
Facilitating pan-European datasets	0	+	0	A consistent ethical framework will remove some barriers for inconsistencies across Member States, but as noted in section 3.1, obstacles to a single digital market when it comes to data faces many other obstacles than data protection and privacy or other ethical issues. It is anticipated that an ethical framework will have only a minor impact.
Providing legal certainty	--	++	+	A consistent legal framework across Member States will make it easier for both developers and users to operate with legal certainty. Differing legal standards across the European Union on ethical considerations would make it more difficult for European companies to understand what standards they should adhere too so that they can easily operate within the entire digital single market.
Projecting EU values	0	+++	++	As noted in in section 3.1, there is already some evidence that new standards being created by European policymakers are influencing jurisdictions outside of Europe. Scenario 1, which provides a more unified view, would increase that impact.

While the report identified five unique points of added value for European regulation, the most significant according to stakeholders and experts is the idea of social acceptance. Some respondents viewed the potential for an eventual pushback against artificial intelligence applications that are viewed with mistrust as a threat to the industry. European legislation has a role to play in fostering trust through ethics and fundamental rights. Any ethical framework which is eventually agreed should be viewed through this prism.

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List of acronyms and abbreviations

1 billion	1 000 million
AI	Artificial intelligence
AI HLEG	High-Level Expert Group on Artificial Intelligence
AML	Anti-money laundering
CAV	Connected and automated vehicles
CCTV	Closed-circuit television
CES	Constant elasticity of substitution
CGE	Computable general equilibrium
EAVA	European Added Value Assessment
ECHR	European Convention on Human Rights
EGE	European Group on Ethics in Science and New Technologies
EPRS	European Parliamentary Research Services
EU	European Union
GDP	Gross domestic product
GDPR	General Data Protection Regulation
GVA	Gross value added
IEEE	Institute of Electrical and Electronics Engineers
KYC	Know your customer
MaaS	Mobility as a service
NACE	Nomenclature des Activités Économiques dans la Communauté Européenne
OECD	Organisation for Economic Co-operation and Development
PRA	Robotic Process Automation
R&D	Research and development
R&D&I	Research, development and innovation
RFID	Radio-frequency identification
SME	Small and medium-sized enterprise
TFP	Total factor productivity
VAT	Value added tax

1. State of play and available regulatory approaches to address ethics in artificial intelligence

Traditionally, innovation policies have driven changes in digital markets, as governments have largely embraced the importance of digitisation to the future competitiveness of the European economy. The Digital Single Market strategy of 2015[2] focusses heavily on its benefits, including better access to consumers and businesses to goods and services. The language of the document makes it clear that the digital market was seen as an extension of existing markets, and that the obstacles identified were very much cross-border issues, such as parcel delivery, geoblocking, multi-territorial licensing, VAT, and a more general issue of trust. The Juncker Commission's discussion on progress to the digital single market also focussed on technical and non-tariff barriers to cross-border work in digital, with successes focussed on the abolition of roaming charges, free Wi-Fi hotspots, and investments in new digital projects.[3]

Five years in the field of digital can be a long time, also in terms of policymaking. Today, the tone of policymakers has shifted quite markedly to a more balanced approach to the field of digital, with the phrase 'a fair and competitive digital economy' appearing in the new digital strategy of the Von der Leyen Commission. Policymakers, as they look to develop a new Digital Services Act, look to legislate responsibilities of digital platforms and ensure that all European companies can compete on 'fair terms'.[4] Fundamental rights and ethics have become an important component to the normal triumvirate of important impacts to analyse along with economic, environmental, and social ones in digital analyses.

The field of artificial intelligence (AI) has received increasing attention of policymakers given the large impacts that it could have on every sector of the European economy as well as on its citizens. President von der Leyen, in her first communication in 2019 on her policy agenda, specifically mentioned the importance of data and artificial intelligence, stating that '[d]ata and AI are the ingredients for innovation that can help us to find solutions to societal challenges... In order to release that potential we have to find our European way, balancing the flow and wide use of data while preserving high privacy, security, safety and ethical standards. We already achieved this with the General Data Protection Regulation […]'.[5]

Much of the literature that discusses ethical principles and AI tend to focus on the challenges presented by specific applications or for specific sectors. There has been a multitude of studies conducted on law enforcement, for example, with themes such as facial recognition,[6] automation in the court system,[7] and the increase of AI in surveillance activities.[8] Within the framework of a Europe that protects, artificial intelligence is seen as a disruptive technology that introduces threats (though rarely opportunities) to the existing *ethical* order. The foundation and types of threats (and opportunities), however, do not always have clearly defined boundaries. This is partly because

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2 European Commission. A Digital Single Market Strategy for Europe. COM(2015) 192 of 6.05.2015.

3 European Commission. President Juncker on the Digital Single Market. 29 September 2017.

4 European Commission. Shaping Europe's Digital Future, February 2020.

5 Leyen, Ursula von der. A Union That Strives for More: My Agenda for Europe, 2019.

6 European Union Agency for Fundamental Rights. Facial Recognition Technology: Fundamental Rights Considerations in the Context of Law Enforcement, 2020.

7 Završnik, Aleš (2020). Criminal Justice, Artificial Intelligence Systems, and Human Rights. *ERA Forum* 20: 4, pp. 567–583.

8 Feldstein, Steven (2019). The Global Expansion of AI Surveillance. Carnegie Endowment for International Peace.

policymakers and experts differ in how they conceptualise artificial intelligence. More importantly, policymakers and experts often group together ethical questions that need to be disentangled.

1.1. How policymakers define AI influences the policy framework

How policymakers and experts define artificial intelligence influences how regulation is defined and framed. One study of face and license plate recognition technologies in the Seattle region found that public servants did not always identify public-sector applications as using AI or algorithmic systems – even when back-end systems used algorithms and machine learning. Officials described artificial intelligence as something that 'learns from its mistakes' or as something that 'becomes increasingly invasive'.[9] But this way of thinking about these technologies can create a blind spots, allowing policymakers to unconsciously exclude technologies and applications from regulatory deliberations.

Definitions of artificial intelligence that exist in the community can also be difficult for policymakers to operationalise, as pointed out by Krafft et al. The IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems defines artificial intelligence as 'autonomous and intelligent technical systems … designed to reduce the necessity for human intervention in our day-to-day lives'. The AI4People Scientific Committee defines it as a technology that 'can hugely enhance human agency'.[10] These definitions lead policymakers to think about technologies and applications with significant impact, but the use of artificial intelligence features in more routine situations. Artificial intelligence has been used, for example, to improve how people can organise and enhance their personal photographs,[11] and is also used in chat bots and virtual assistants.[12]

Exploring the extensive literature on defining artificial intelligence, researchers Stuart Russel and Peter Norvig provide a helpful breakdown of definitions along four axes, as illustrated in the following table:

Table 3: Definitions of artificial intelligence

Thinking Humanly	**Thinking Rationally**
Based on a cognitive modelling approach, definitions fitting this category focus on whether artificial intelligence processes information in ways similar to the way that a human would.	Based on a 'laws of thought' approach, thinkers in this category work with definitions that are based on logical thinking and syllogisms.
Acting Humanly	**Acting Rationally**
Based along thinking from Alan Turing that computers need to have natural language processing, knowledge representation, automatized reasoning, and machine learning to be defined as intelligent.	Based on a 'rational agent' approach, it focusses on decisions that are being made where applications look for the best outcome.

Source: Russell, Stuart J., Peter Norvig, and Ernest Davis (2010). Artificial Intelligence: A Modern Approach. 3rd ed. Prentice Hall Series in Artificial Intelligence. Upper Saddle River: Prentice Hall.

[9] Young, Meg, Michael Katell, and P. M. Krafft (2019). Municipal Surveillance Regulation and Algorithmic Accountability. *Big Data & Society* 6:2.

[10] Krafft, P. M., Meg Young, Michael Katell, Karen Huang, and Ghislain Bugingo (2020). Defining AI in Policy versus Practice. *Proceedings of the AAAI/ACM Conference on AI, Ethics, and Society*, 72–78. New York NY USA: ACM.

[11] Skylum (n.d.). 6 Ways Artificial Intelligence Can Boost Every Photographer's Business.

[12] Marr, Bernard (2020). How Artificial Intelligence Is Making Chatbots Better For Businesses. *Forbes*.

Each of these definitions provides a prism through which to think about the regulation of artificial intelligence and ethics that change the focal point of analysis. Definitions that focus on the 'humanity' of artificial intelligence are more likely to consider processes – ensuring that machine learning is developed in an ethical manner – while those that focus on rationality are more likely to evaluate the outputs of artificial intelligence, checking whether applications lead to ethical results.

The European Commission's High-Level Expert Group on AI (AI HLEG), which leads European thinking on matters of artificial intelligence, focusses on rationality. Human agency as a concept only appears with the statement that people are responsible for designing AI systems, but otherwise, the focus is on the logical collection and processing of data to decide on the 'best outcome'. To quote the definition in full:[13]

> *'Artificial intelligence (AI) systems are software (and possibly also hardware) systems designed by humans that, given a complex goal, act in the physical or digital dimension by perceiving their environment through data acquisition, interpreting the collected structured or unstructured data, reasoning on the knowledge, or processing the information, derived from this data and deciding the best action(s) to take to achieve the given goal. AI systems can either use symbolic rules or learn a numeric model, and they can also adapt their behaviour by analysing how the environment is affected by their previous actions.'*

This difference between thinking in a human-like way versus a focus on rationality can also be seen in the list of ethical considerations provided by the European Parliamentary Research Services (EPRS) on the ethics of artificial intelligence. This report identifies 12 key ethical issues:[14]

1. '***Human rights and well-being?*** *Is AI in the best interests of humanity and human well-being?*
2. ***Emotional harm****. Will AI degrade the integrity of the human emotional experience, or facilitate emotional harm?*
3. ***Accountability and responsibility****. Who is responsible for AI, and who will be held accountable for its actions?*
4. ***Security, privacy, accessibility, and transparency****. How do we balance accessibility and transparency with privacy and security, especially when it comes to data and personalisation?*
5. ***Safety and trust****. What if AI is deemed untrustworthy by the public, or acts in ways that threaten the safety of either itself or others?*
6. ***Social harm and social justice****. How do we ensure that AI is inclusive, free of bias and discrimination, and aligned with public morals and ethics?*
7. ***Financial harm****. How will we control for AI that negatively affects economic opportunity and employment, and either takes jobs from human workers or decreases the opportunity and quality of these jobs?*
8. ***Lawfulness and justice****. How do we go about ensuring that AI – and the data it collects – is used, processed, and managed in a way that is just, equitable, and lawful, and subject to appropriate governance and regulation? What would such regulation look like? Should AI be granted 'personhood'?*
9. ***Control and the ethical use – or misuse – of AI****. How might AI be used unethically – and how can we protect against this? How do we ensure that AI remains under complete human control, even as it develops and 'learns'?*
10. ***Environmental harm and sustainability****. How do we protect against the potential environmental harm associated with the development and use of AI? How do we produce it in a sustainable way?*

[13] AI HLEG. A Definition of AI: Main Capabilities and Disciplines, 8 April 2019 .

[14] Bird, Eleanor, Jasmin Fox-Skelly, Nicola Jenner, Ruth Larbey, Emma Weitkamp and Alan Winfield (2020). The ethics of artificial intelligence: Issues and initiatives. STOA Study.

11 ***Informed use***. *What must we do to ensure that the public is aware, educated, and informed about their use of and interaction with AI?*

12 ***Existential risk***. *How do we avoid an AI arms race, pre-emptively mitigate and regulate potential harm, and ensure that advanced machine learning is both progressive and manageable?'*

Within this list, the idea of artificial intelligence as a technology that should be granted 'personhood' very much falls under the umbrella of thinking of this technology in human terms with its own sense of agency. It assumes that the regulatory framework needs to focus on the technology itself rather than on the programmers responsible for creating the code or the users that are responsible for rolling out the tools. For those who define ethics from this rational perspective, some of the ethical considerations listed in the EPRS report could be considered ethical failings of people, not of the technology.

1.2. Embedded and emerging ethical standards

In addition to the process versus output definitions of artificial intelligence, which causes policymakers and experts to frame ethical challenges in different terms, it is also important to understand that there are two types of ethical issues that artificial intelligence is raising. This challenge might best be described as the difference between established rights and emerging rights. Disentangling these two types of rights are important because it influences how to think about the policy framework that is already regulating the development and use of the technology from new elements of the framework that have recently been passed or are currently being debated.

Established ethical principles are ideas that are embedded within Europe's current legal and policy frameworks and encompass many of the ideas enshrined within the EU Charter of Fundamental Rights.[15] Without laying out all of the articles of the Charter, a few primary and well-recognised examples include freedom of thought, conscience and religion (Article 10), freedom of assembly and of association (Article 12), equality before the law (Article 20), and non-discrimination (Article 21). It would be well outside the scope of this report to describe the history of how these ethical standards have developed over the decades, but in these cases, the threat or opportunity that artificial intelligence presents is in that the technology makes organisations more effective. The use of facial recognition software at rallies or protests does not present a new threat to the freedom to assemble, but rather magnifies (by admittedly a large amount) an existing instrument of tracking individuals, which might discourage some who want to remain anonymous.[16]

Emerging ethical concerns are those that have been given a new impetus by the onset of the digital economy. The best example of an emerging ethical consideration is over data privacy, which has become a right in and of itself, rather than a component of some other right. The EU Charter, through Article 8, makes clear that the European Union considers the protection of personal data is an independent right:

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15 Charter of Fundamental Rights of the European Union, OJ C 326 of 26.10.2012.

16 Even within facial recognition, there is an interesting distinction between the use of the technology itself versus those that show concern over the false positives that it creates (giving more false positives for visible minorities). For a discussion of various ethical concerns, see Raji, Inioluwa Deborah, Timnit Gebru, Margaret Mitchell, Joy Buolamwini, Joonseok Lee, and Emily Denton (2020). Saving Face: Investigating the Ethical Concerns of Facial Recognition Auditing. *ArXiv:2001.00964 [Cs]*..

1 ‘Everyone has the right to the protection personal data concerning him or her.
2 Such data must be processed fairly for specified purposes and on the basis of the consent of the person concerned or some other legitimate basis laid down by law. Everyone has the right of access to data which has been collected concerning him or her, and the right to have it rectified.
3 Compliance with these rules shall be subject to control by an independent authority.’

This is not to say that data protection has not been a concern of governments. International (legal) frameworks for data protection and privacy have existed with the 1980 OECD Guidelines and the European Union Data Protection Directive from the 1980s and 1990s.[17] But the focus is still on the ethical considerations around what would be done with this data, whereas now, ownership of data is an ethical concern on its own. A whole branch of data ethics has emerged, as embodied in the work of researchers like Luciano Floridi and Taddeo Mariarosaria, where they argue that the field ‘highlights the need for ethical analyses to concentrate on the content and nature of computational operations – the interactions among hardware, software and data – rather than on the variety of digital technologies that enable them’.[18]

This distinction between emerging and established rights can be seen in recent surveys on various elements of ethics and rights. It remains clear that many people understand the idea of non-discrimination, but the idea that data privacy as a right is less accepted as an ethical consideration. In the 2019 Eurobarometer survey on discrimination in the European Union, a question around whether discrimination is something that deserves protection does not appear (it is quite likely that the designers of the survey would not even have considered it a legitimate question).[19] Yet, in the same year, Cisco put out a global survey of attitudes towards data privacy, a survey in which most of the questions were centred around the question of whether people believed that data privacy was important and who would be responsible for it (whether government or industry).[20] While data privacy and protection have equal stature under the Charter to the right to non-discrimination, and each has a clear ethical component, they clearly do not have the same stature in the minds of ordinary citizens and norms are still developing with policymakers.

This distinction is important both for understanding how ethical standards are being legislated, but also how experts understand the effects of an ethical framework on the economic and social well-being of European citizens. From a developer’s perspective, access to less data has a clear impact on the speed of development and the accuracy of results from AI applications. Studies on the impact of the General Data Protection Regulation (GDPR)[21] on companies have only just begun to appear, but they show a clear impact as organisations dedicate resource to meeting their data privacy obligations. An April 2020 study by James Bessen et al examining AI startups and their relationship with data and the GDPR showed that European companies were more likely to develop relationships with American big-tech firms to get access to data.[22] While the results of this study are somewhat

[17] Tene, O. (2011). Privacy: The New Generations. *International Data Privacy Law* 1:1, pp. 15–27..

[18] See the abstract to Floridi, Luciano, and Mariarosaria Taddeo (2016). What Is Data Ethics? *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 374: 2083.

[19] Kantar (2019). Discrimination in the European Union. Special Eurobarometer 493.

[20] Cisco (2019). Consumer Privacy Survey: The Growing Imperative of Getting Data Privacy Right.

[21] Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC, OJ L 119 of 04.05.2016.

[22] Bessen, James E., Stephen Impink, Lydia Reichensperger, and Robert Seamans (2020). GDPR and the Importance of Data to AI Startups. *NYU Stern School of Business*.

vague on what the economic impact will be on startups – in particular in the longer term – they show that GDPR and issues around data privacy do have a measurable operational impact.

The impact of an ethical framework on these emerging rights of data privacy and protection requirements, while unclear, is at least a discrete topic of study. The impact of an ethical framework for ideas that are already embedded in both policy, law, and the wider society even less clear. Qualitative discussion of the impact of artificial intelligence on various ethical considerations – some of which are also discussed in Chapter 2 of this report – sometimes assume that AI applications are making decisions that threaten current ethical standards. Some reports even make it sound like these applications could make decisions without outside intervention, and that a new legal framework needs to be in place to create safeguards. However, plenty of protections already exist, and artificial intelligence does not require a completely new set of laws and principles to encode our ethical standards. Specific questions around transparency – a necessity for auditing and ensuring legal compliance – exist, but they are limited in number and scope.

1.3. European ethical guidelines in relation to artificial intelligence

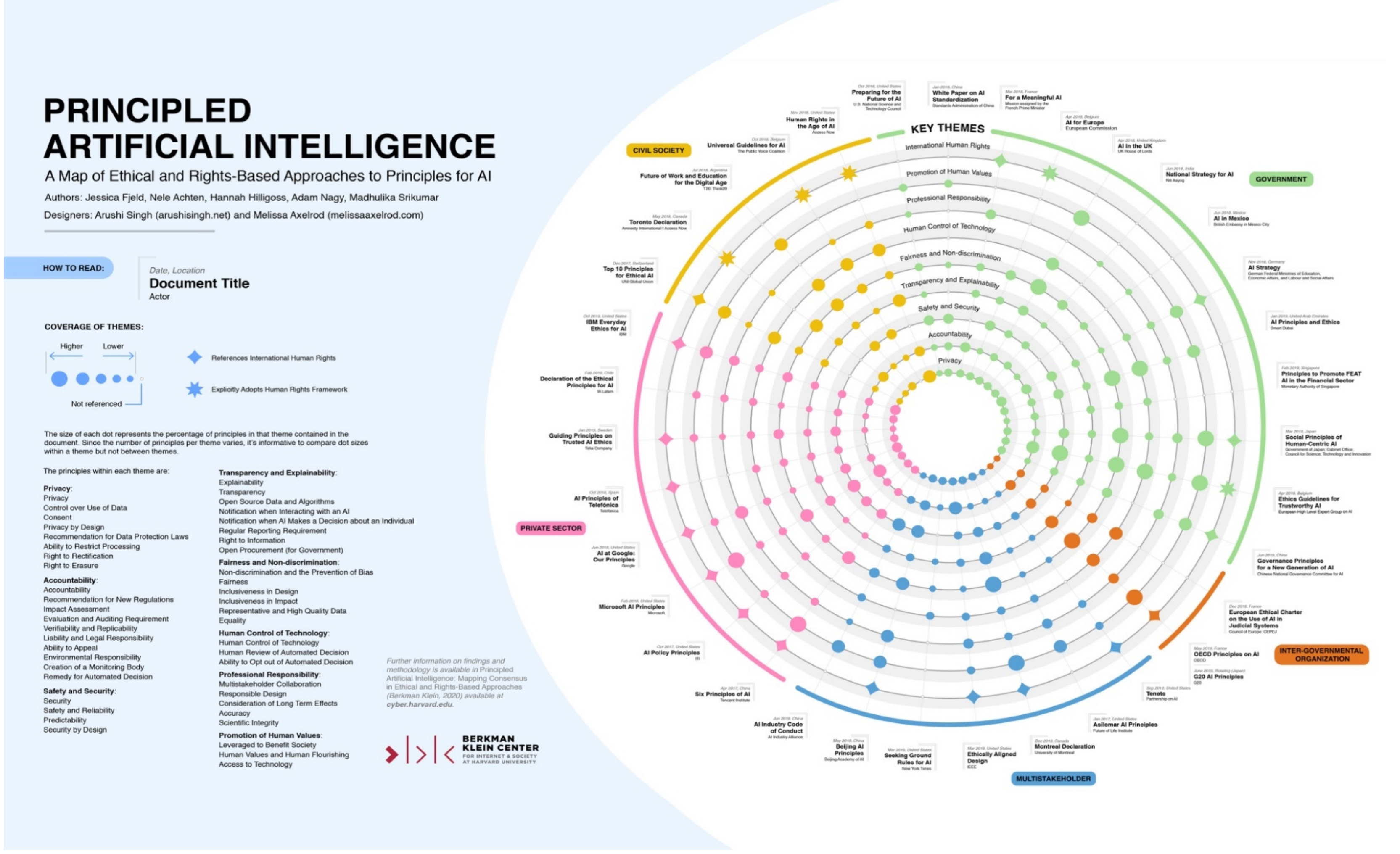
As mentioned above, there have been plenty of guidelines and principles developed by various organisations on the use of artificial intelligence. A recent study from the Berman Klein Center mapped the ethical and rights-based approaches to principles of artificial intelligence, identifying 36 organisations, from private and public sector – including the EU – that have developed principles and guidelines for artificial intelligence, as shown in the figure below. The AI Ethics Guidelines Global Inventory by Algorithm Watch[23] currently contains more than 160 guidelines.[24] The first analysis of ethical guidelines by Algorithm Watch found that most of them are 'positioned between instrumental-economic and ethical perspectives' and that 'AI ethics in this sense is rather business ethics'.[25] This means that most guidelines aim to shape business practices and conduct through ethically sound recommendations about, for instance, compliance, manufacturing processes, treatment of misconduct and socially responsible entrepreneurship.

[23] The official website: https://algorithmwatch.org/en/project/ai-ethics-guidelines-global-inventory/ .

[24] González Fuster, Gloria (2020). Artificial Intelligence and Law Enforcement - Impact on Fundamental Rights. Study for the European Parliament's Committee on Civil Liberties, Justice and Home Affairs, p. 55.

[25] Gießler, Sebastian and Leonard Haas (2020). Ethics between business lingo and politics: Why bother?

Figure 1: A map of ethical and rights-based approaches to AI



Source: Fjeld, Jessica, Nele Achten, Hannah Hilligoss, Adam Nagy, and Madhulika Srikumar (2020). [Principled Artificial Intelligence: Mapping Consensus in Ethical and Rights-Based Approaches to Principles for AI](). Berkman Klein Center Research Publication No. 2020-1.

The EU ethical framework for AI distinguishes itself from the rest as it follows the lead of the EU Charter of Fundamental Rights[26] and has been an integral part of the EU policy development in relation to AI.[27] The EU policy documents firmly place people in the centre of AI development (i.e. human-centric AI) and aim to ensure that new technologies built and used in the EU are based on values. This will be achieved through three interdependent elements: boosting the EU's technological and industrial capacity and AI uptake, preparation for socio-economic changes and establishing an appropriate ethical and legal framework. The ethical framework should be based with Article 2 of the Treaty on European Union and the Charter of Fundamental Rights of the EU and build on the work of the European Group on Ethics in Science and New Technologies (EGE).[28] It should address issues of the future of work, fairness, safety, security, social inclusion and algorithmic transparency and consider the AI impact on fundamental rights.[29]

The ethical guidelines called 'Ethics Guidelines for Trustworthy AI' (the Guidelines)[30] were drafted in a collaborative effort by an interdisciplinary stakeholder group set up by European Commission: High-Level Expert Group for Artificial Intelligence (AI HLEG). The Guidelines define 'trustworthy AI' as the one that consists of three components that should be met throughout the entire course of AI's life. The AI should be:

1. Lawful (i.e. complying with all applicable laws and regulations),
2. Ethical (i.e. adhering to ethical values and principles), and
3. Robust (i.e. not causing harm from technical and social perspectives).

Inspired by fundamental rights and building on the nine basic ethical principles proposed by the EGE, the AI HLEG developed four ethical principles that are also ethical imperatives that must be respected in the development, deployment and use of AI:[31]

1. Respect for human autonomy: From ethical perspective, autonomy is a quality that can be attributed only to human beings. It is expressed in the human abilities to be self-aware, self-conscious and a self-author, meaning being able to set own rules and standards and choose own goals and purposes in life. Autonomy is a central aspect of human dignity and agency. Through human dignity, autonomy is the foundation of human rights, and it implies that it is inappropriate 'to manage and decide about humans in the way we manage and decide about objects or data, even if this is technically conceivable'.[32] Therefore, respect for human autonomy requires that there is a meaningful human intervention and participation in AI and that AI systems should not 'subordinate, coerce, deceive, manipulate, condition or herd humans'.[33]

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26 Boucher, Philip (2020). Artificial intelligence: How does it work, why does it matter, and what can we do about it? STOA Study, p. 51.

27 European Commission. Artificial Intelligence for Europe. COM(2018) 237 of 25.04.2018; European Commission. Coordinated Plan on Artificial Intelligence, COM(2018) 795 of 07.12.2018.

28 European Group on Ethics in Science and New Technologies. Statement on Artificial Intelligence, Robotics and 'Autonomous' Systems, 9 March 2018.

29 European Commission. Artificial Intelligence for Europe. COM(2018) 237 of 25.04.2018, pp. 3, 14-15. See also: European Commission. Building Trust in Human-Centric Artificial Intelligence, COM(2019) 168 of 08.04.2019 and White Paper on Artificial Intelligence – A European approach to excellence and trust, COM(2020) 65 of 19 February 2020.

30 AI HLEG. Ethics Guidelines for Trustworthy AI Disciplines, 8 April 2019.

31 Ibid, pp. 11-13.

32 European Group on Ethics in Science and New Technologies. Statement on Artificial Intelligence, Robotics and 'Autonomous' Systems, 9 March 2018, p. 9.

33 AI HLEG. Ethics Guidelines for Trustworthy AI Disciplines, 8 April 2019, p.12.

2 Prevention of harm: The second principle addresses directly both physical and mental well-being of people interacting with artificial intelligence systems. Importantly, vulnerable people should be included in development deployment and use of AI, and that impacts of AI studied to ensure that they are not creating or exacerbating harmful practices. Implications for natural environment and all living beings need to be considered in the AI context. Both AI systems and environments in which they operate need to be safe and secure (technically and otherwise).

3 Fairness: Fairness involves both process and substance. While the AI HLEG acknowledge that fairness can be interpreted in many ways, they indicate the main elements or commitments. From the substantive perspective, fairness means ensuring equal and just distribution of benefits and costs, freedom from unfair bias, discrimination and stigmatisation, freedom of choice and respect of proportionality between means and ends. From the procedural perspective, fairness entails the ability to contest and seek effective redress against decision made by AI and humans operating them. Accountability of AI operators and explicability of AI decisions are crucial for this principle.

4 Explicability: The final principle follows directly from the principle of human autonomy as it is a part of human agency to be able and willing to take and attribute moral responsibility (i.e. causality, accountability and liability).[34] Explicability also underpins and gives effectiveness to other principles. AI's capabilities, purpose and decisions need to be explainable to those who are directly or indirectly affected by them. The AI HLEG suggests that the degree of explicability is determined by the context and the severity of the consequences if AI's output is erroneous or inaccurate.

The Guidelines also provide guidance that 'trustworthy AI' can be realised by ensuring that the development, deployment and use of AI systems meet seven key requirements:

1 Human agency and oversight,
2 Technical robustness and safety,
3 Privacy and data governance,
4 Transparency,
5 Diversity, non-discrimination and fairness,
6 Environmental and societal well-being and
7 Accountability.

To operationalise the ethical principles and key requirements, the Guidelines contain an assessment list that offers practical guidance for companies. Companies were invited to test the assessment list in a piloting process that ran in 2019. Based on the feedback received during this pilot, the AI HLEG should update the assessment list and publish its revised version in 2020.[35]

[34] European Group on Ethics in Science and New Technologies. Statement on Artificial Intelligence, Robotics and 'Autonomous' Systems, 9 March 2018, p. 10.

[35] European Commission (2019). Pilot the Assessment List of the Ethics Guidelines for Trustworthy AI..

1.4. Current policy and legal developments at the EU level

Although research on ethics of AI goes back decades,[36] the recent relevant debates at the EU level tend to blur boundaries between ethics, law and policy. Some EU-level actors perceive an ethical framework as a first step towards later regulation. Others consider fundamental rights, and specifically the GDPR, a focus of an ethical framework or an ethical standard. Yet others discuss the possibility of developing of an AI ethics as a discipline of its own.[37] As the policy debates are still ongoing, it is difficult to predict, which of the views and approaches will prevail. The adoption of the AI HLEG Ethical Guidelines seems to suggest that, for the moment, a stand-alone ethical framework is sufficient. However, transition to embedding ethics is law cannot be ruled out, based on the ambitions by EU-level policymakers,[38] as well as adoption or revision of legislation inspired by ethical insights.[39]

The European Parliament has been driving the EU debate on regulation of AI, including on the necessity of an ethical framework at the EU level. In 2017, the European Parliament adopted a Resolution on civil law rules on robotics[40] that called on the European Commission to assess the impact of AI. This Resolution also recommended a Code of Ethical Conduct for Robotics Engineers and suggested licences both for designers and users. The European Parliament also asked the European Commission to consider whether a 'European Agency for robotics and artificial intelligence' should be created to provide, among other things, ethical and regulatory expertise for the EU and Member State level to ensure a 'timely, ethical and well-informed response' to opportunities and challenges of AI. In the same year, the Council identified AI as a trend that needed to be urgently addressed and invited the European Commission to develop a European AI approach that ensures 'a high level of data protection, digital rights and ethical standards'.[41]

In 2018, the European Commission adopted a communication,[42] which laid out steps to address ethical concerns. It proposed to bring together relevant stakeholders to draft ethical guidelines for AI. The European Commission then established High-Level Expert Group on AI, composed of 52 independent experts, that developed a set of non-binding Ethics guidelines for trustworthy AI. Published in 2019, this document offers guidance on how to foster and secure the development of ethical AI systems in the EU. There is some scepticism regarding the added value of a stand-alone ethical framework, like the AI HLEG Ethical Guidelines, because they are not mandatory and lack

36 See Stanford Encyclopedia of Philosophy (2020). Ethics of Artificial Intelligence and Robotics. The reference list to the article dates back to the 1970s and beyond.

37 For an analysis of positions by different actors see González Fuster, Gloria (2020). Artificial Intelligence and Law Enforcement - Impact on Fundamental Rights. Study for the European Parliament's Committee on Civil Liberties, Justice and Home Affairs, pp. 54-57.

38 See also the recommendation to 'shift from voluntary to binding' in the recent STOA Study. This recommendation also refers to 'reorienting the discussions about AU ethics to AI rights'. Boucher, Philip (2020). Artificial intelligence: How does it work, why does it matter, and what can we do about it? STOA Study, p. 52.

39 van Wynsberghe, Aimee (2020). Artificial intelligence: From ethics to policy. STOA Study, p.24.

40 European Parliament resolution of 16 February 2017 with recommendations to the Commission on Civil Law Rules on Robotics (2015/2103(INL)); see also Committee on Legal Affairs of the European Parliament. Report of 27.01.2017 with recommendations to the Commission on Civil Law Rules on Robotics, (2015/2103(INL)).

41 Conclusions of the European Council meeting of 19.10.2017 (EUCO 14/17), p. 7.

42 European Commission. Artificial Intelligence for Europe. COM(2018) 237 of 25.04.2018.

enforcement mechanisms. Their effects will be difficult to measure, and it will be impossible to determine whether AI developments and users are actually following the guidelines.[43]

Some of the ethical principles outlined by the AI HLEG are already embedded within Member State and European law. While the legal framework bears few specific references to AI, this does not mean that the existing framework fails to address some ethical considerations coming out of its application. All the main issues related to ethics and fundamental rights – such as data protection, privacy, non-discrimination and procedural rights – are regulated under generic statutes such as EU Charter of Fundamental Rights, the GDPR, the legislation implementing E-Privacy Directive[44] and the E-Commerce Directive[45] as well as the European Convention on Human Rights (ECHR).[46]

Another string of legislation relevant for ethical concerns about AI is that on transparency of different areas of digital economy. In 2019, the Platform to Business Regulation was adopted that provides for more transparent and fair relationships between online intermediation services and online search engines and their business users.[47] More policy actions on increasing transparency are likely to follow as suggest by recent activities by the European Commission and the European Parliament. The European Commission is currently carrying out an in-depth analysis of algorithmic transparency and accountability.[48] The European Parliament's study of 2019 argues for the creation of a regulatory body with expertise in analysing algorithmic decision-making systems and a network of external expert advisors.[49]

Legislation on safety and liability for AI-based application is pivotal in addressing ethical concerns and ensuring citizens' and users' trust and acceptance of the technology. While there are several legal acts at the EU level dealing with civil liability in general (foremost the General Product Safety Directive[50] and Product Liability Directive[51]) and in application to particular sectors (for example, the

43 González Fuster, Gloria (2020). Artificial Intelligence and Law Enforcement - Impact on Fundamental Rights. Study for the European Parliament's Committee on Civil Liberties, Justice and Home Affairs, p. 55; van Wynsberghe, Aimee (2020). Artificial intelligence: From ethics to policy. STOA Study, p. 24.

44 Directive 2002/58/EC of the European Parliament and of the Council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector, OJ L 201 of 31.07.2002.

45 Directive 2000/31/EC of the European Parliament and of the Council of 8 June 2000 on certain legal aspects of information society services, in particular electronic commerce, in the Internal Market, OJ L 178 of 17.7.2000.

46 Convention of the Council of Europe for the Protection of Human Rights and Fundamental Freedoms of 4 November 1950 (with protocols) .

47 Regulation (EU) 2019/1150 of the European Parliament and of the Council of 20 June 2019 on promoting fairness and transparency for business users of online intermediation services, OJ L 186 of 11.07.2019.

48 For details see: https://ec.europa.eu/digital-single-market/en/algorithmic-awareness-building#:~:text=Algorithmic%20transparency%20is%20an%20important,and%20fairness%20in%20decision%2Dmaking.&text=Following%20a%20proposal%20of%20the,opportunities%20in%20algorithmic%20decision%2Dmaking. .

49 For reasoning and details on the functions and responsibilities see Koene, Ansgar, Chris Clifton, Yohko Hatada, Helena Webb, Menisha Patel, Caio Machado, Jack LaViolette, Rashida Richardson, Dillon Reisman (2019). A governance framework for algorithmic accountability and transparency. STOA study.

50 Directive 2001/95 of the European Parliament and of the Council of 3 December 2001 on general product safety, OJ L 11 of 15.01.2002.

51 Council Directive 85/374/EEC of 25 July 1985 on the approximation of the laws, regulations and administrative provisions of the Member States concerning liability for defective products, OJ L 210 of 07.08.1985.

General Vehicles Safety Regulation[52]), the discussion and research are still ongoing about what the appropriate regulatory approaches should be.[53]

1.5. What this means for the EAVA and other challenges for this analysis

Introducing and possibly regulating an ethical framework for artificial intelligence, which this study looks to analyse and measure, requires not only understanding legitimate gaps in the existing framework, but also understanding that ethical considerations permeate every level of European law and policy. Depending on the sector and the issue, there are hundreds of legal measures that could be brought to bear to challenge any ethical violations brought about by artificial intelligence. With this said, there are niche issues specific to artificial intelligence and big data, such as the issue of explicability that are relatively concrete and not open to interpretation or debate. Regulations that call for a data officer to be hired at companies of a certain size or require a degree of transparency of algorithms require certain resource. Requiring applications to adhere to a standard of fairness, however, is less clear.

For this reason, this analysis has chosen a methodological approach that avoids a precise definition of ethics. We use an approach, as described in the next chapters, that provides freedom to a large group of experts to consider the overall impacts of an ethical framework on artificial intelligence.

52 Regulation 2019/2144 of the European Parliament and of the Council of 27 November 2019 on type-approval requirements for motor vehicles and their trailers, and systems, components and separate technical units intended for such vehicles, as regards their general safety and the protection of vehicle occupants and vulnerable road users, OJ L 325 of 16.12.2019.

53 On possible approaches see Bertolini, Andrea (2020). Artificial Intelligence and Civil Liability. Study for the European Parliament's Committee on Legal Affairs; Martens, Bob and Jorren Garrez (2019). Cost of non-Europe in robotics and artificial intelligence: Liability, insurance and risk management. EPRS study; Evas, Tatjana (2018). A common EU approach to liability rules and insurance for connected and autonomous vehicles. European Added Value Assessment Accompanying the European Parliament's legislative own-initiative report (Rapporteur: Mady Delvaux). On policy developments see European Commission. Report on the safety and liability implications of Artificial Intelligence, the Internet of Things and robotics, COM(2020) 64 of 19.02.2020; Committee on Legal Affairs (2020). Draft report with recommendations to the Commission on a Civil liability regime for artificial intelligence (2020/2014(INL)).

2. Macro-economic impact of EU Framework on Ethical Aspects of AI, robotics and related technologies

The analysis of the macro-economic implications of an EU framework on ethical aspects of AI, robotics and related technologies focuses on eight fundamental sectors of the EU economy. The selection of sectors was motivated by two main considerations – the importance of the sector in the EU economy and the anticipated effect of ethical AI on the sector. Overall, we strived to have a diverse sample of sectors with regards to the two aforementioned factors.

In terms of economic importance, our sample represents sectors with varying levels of contribution to the EU economy. More specifically, the **transport sector** is a major contributor, given that in 2016 it represented more than 9 % of the EU gross value added.[54] In 2019, the sector accounted for 5 % of GDP. Similarly, **health care** is also a key sector in the EU economy, as in 2016, the human health and social work sector represented approx. 7.4 % of gross value added;[55] in 2017, the EU as a whole devoted 9.6% of its GDP to health care. The **automotive industry** is also of crucial importance – while this sector's GVA only amounted to 1.5 % in 2013,[56] currently the turnover generated by the automotive industry represents over 7 % of EU GDP.

These sectors are followed by **construction**, and **financial services** whose contributions to the EU economy are also relatively high, as the gross value added of these sectors to the EU economy in 2018 amounted to 5.6 %, and 4.8 %, respectively.[57] The importance of the remaining three sectors is somewhat lower. That is, the **energy sector** generates about 4% of value added of the non-financial EU business economy,[58] while **telecommunications** in 2018 contributed 27.3 % to the sectoral value added of information and communication, whose GVA in the same year was 5.1 %.[59] Finally, the gross value added of **agriculture** (which also includes forestry and fishing) in 2018 was 1.6 %[60] and the sector contributed 1.1 % to the EU's GDP in the same year.

Some of the selected sectors (telecommunications, automotive, financial services, energy and health care) are more advanced in AI deployment than others (e.g. construction).[61] What is more, our selection also comprises of sectors wherein the impact of ethical AI is expected to be significant and ones where no big differences are foreseen between the implementation of unfettered AI and that of ethical AI. Namely, while the effect of ethical AI is expected to be substantial in transport, financial services, health care, and (to a lesser extent) construction, the effect on the telecommunications, energy, and agriculture sectors as well as the automotive industry is expected to be milder.

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54 EU's website on transport: https://europa.eu/european-union/topics/transport_en.

55 Darvas, Zsolt, Nicolas Moës, Yana Myachenkova and David Pichler (2018). The macroeconomic implications of healthcare. Brueghel Policy contribution No11.

56 Bank of Finland (2016). Significance of the car industry in EU countries.

57 Eurostat (2019). National accounts and GDP

58 EU Science Hub (2020). Energy Sector Economic Analysis

59 Eurostat (2019). National accounts and GDP

60 Ibid.

61 Eager, James, Mark Whittle, Jan Smit, Giorgio Cacciaguerra and Eugénie Lale-Demoz (2020). Opportunities of Artificial Intelligence. Study for the European Parliament's committee on Industry, Research and Energy, pp. 19-27.

The use of such a diverse sample of (key) sectors allows us to extrapolate and generalize the results of the analysis to the overall EU economy.

2.1. Agriculture

Agricultural sector (agriculture) in the EU encompasses different economic activities associated with production and distribution of products from plants and animals. This includes soil and land cultivation, farm production and management of crops and livestock, manufacturing of plant and animal materials and processing them into final products, as well as provision of them to consumers.

Aspiring to become a fair, healthy, environmentally friendly yet resilient sector,[62] agriculture faces a number of serious ethical issues[63] that may be relevant in discussing the application of AI for this sector:

1 Sustainability and environmental impact of agriculture (both nature and natural resources): Agriculture causes soil degradation and water contamination, e.g. due to using toxins and chemicals, overuse of fertilizers, harmful soil transformation. It destroys natural habitats for insects and wildlife, reduces biodiversity, contributes to soil erosion and depletion of water resources. In the long run, agriculture in its current form will not persist.

2 Animal ethics (animal welfare) refers not only about 'happiness' of animals (keeping animals in mass stocks and intensive breeding), but also about using steroids and antibiotics to intensify meat production (ultimately raising health concern questions for humans), extensive use of land for the production of foodstuffs for animals and overall environmental impact of intensive animal husbandry.

3 Human health (safe and nutritious food): the quality and safety of food produced with the current agricultural methods are questionable.

4 Farm structure and farm management: the increasing farm size and emergence of agri-tech raise issues ranging from treatment of farm workers to the position and sustainability of SMEs in the sector (including their market shares) as well as whether farms are owner-operated.

5 Food security and distribution:[64] while the productivity of agriculture has increased significantly, the distribution of nutritious and safe food continues to be a challenge. Climate change and adverse environmental impacts of agriculture exacerbates risks linked to malnutrition.

6 Agricultural biotechnology (agri-tech) relates to the use of genetically modified crops; the patented research and production of seeds and the mode of their distribution and control by a few multinational corporations; as well as ethical agricultural production and the ability to monitor and trace it (e.g. that coconut

[62] European Commission. Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system, COM(2020)381 of 20 May 2020.

[63] The most authoritative discussion can be found in Food and Agriculture Organization of The United Nations (2001). Ethical issues in food and agriculture. See also Korthals, Michiel (2014). Agricultural ethics. In: Encyclopaedia of Global Bioethics. Springer Science; Bhardwaj, Minakshi, Fumi Maekawa, Yuki Niimura and Darryl RJ Macer (2003). Ethics in Food and Agriculture: Views from FAO. *International Journal of Food Science and Technology* 38:5, pp. 565-588.

[64] Wilkinson, John (2015). Food security and the global agrifood system: Ethical issues in historical and sociological perspective. *Global Food Security* 7, pp. 9-14.

butter was not produced on the previously deforested land by underpaid workers or that indigenous people were not driven out of the land for coffee plantations).

7 Data access and sharing: agricultural companies (especially SMEs) face increased pressure to share valuable company data, as a prerequisite of participation in data pooling initiatives that facilitate crucial input for precision agriculture or agri-tech.

Note that if AI applications are unfettered, this ethical dimension is not relevant, and the AI may focus on whatever objectives are desirable by the developer (e.g. productivity).

2.1.1. What shocks the AI use in agriculture is likely to produce

According to a 2018 market analysis by the McKinsey Global Institute,[65] the economic value added by implementing AI-techniques to agriculture is, on a global level, estimated to be US$486.3 billion, of which US$322.1 billion come from the use of traditional AI and analytics, such as machine learning, whilst US$164.2 billion emanate from the deployment of advanced AI-technology and tools (e.g. deep learning neural networks). According to 2016 figures, the predicted added value equates to 11.05 % of global sector-sales.

Precision agriculture (smart farming) will be possible with AI.[66] Precision agriculture uses AI to detect diseases in plants, pests, poor plant nutrition. Ai applications can detect and target weeds, decide when to use herbicides, which would reduce the overall amount of herbicides and pesticides used and make it more targeted. AI also can be used for tracing genomics of plants. AI will *help analysing data for better forecasting and farming.* Farmers analyse a lot of environmental data to decide where and when to plant, harvest etc. The data necessary for AI: weather conditions, temperature, water usage by the farm, soil and water conditions etc. The concrete applications here are for monitoring everything – either with drones or with sensors.

AI, sensors and big data analytics coupled with robotics will be able to execute some of the work on farms. Agricultural robots (agribots) and drones already are used for weed control (e.g. aerial spraying), data collection (e.g. crop monitoring, livestock monitoring, health assessment, crop readiness identification) and field management (e.g. automated data based irrigation). Their future applications will expand to seeding, thinning and planting as well as harvesting of various crops.[67] This helps addressing the *problem of dwindling workforce,*[68] *increase productivity* and will free more time for management tasks.[69] Not only will these applications save time while yielding more results, they will lead to more efficient use of agricultural inputs: less water and fertilisers, fewer seeds, more targeted work efforts when harvesting. The deployment of AI and data analytics in *farm*

[65] McKinsey Global Institute (2018): https://www.mckinsey.com/business-functions/mckinsey-analytics/our-insights/the-executives-ai-playbook?page=industries/agriculture/

[66] On the benefits of precision agriculture see: Soto, I., Barnes, A., Balafoutis, A., Beck, B., Sanchez, B., Vangeyte, J., Fountas, S., Van der Wal, T., Eory, V., Gómez-Barbero, M. (2019). The contribution of Precision Agriculture Technologies to farm productivity and the mitigation of greenhouse gas emissions in the EU. Publications Office of the European Union, Luxembourg; Schieffer, J., Dillon, C. (2015). The economic and environmental impacts of precision agriculture and interactions with agro-environmental policy. *Precision Agriculture* 16, pp. 46–61.

[67] An overview of current applications and developments: Senaar, Kumba (2019). Agricultural Robots – Present and Future Applications. Emerj

[68] The data shows a significant 30%-decline of the total labour force employed in farming between 2003 and 2013 in the EU according to Schuh, B et al. (2019). Research for AGRI Committee – The EU farming employment: current challenges and future prospects, European Parliament, Policy Department for Structural and Cohesion Policies.

[69] Hooijdonk, Richard van (2019). 4 Ways Robotics Will Affect Agriculture in 2019 .

management will contribute to better planning and optimal use of resources as well as give farmers *more control over the supply and distribution chains*.

However, with technology and R&D becoming the main drivers of the sector, the intensification and mechanisation of agriculture create *access barriers for market entrants*,[70] because competing as a farming company becomes increasingly costly – especially for small scale or family-based farms. The limited economic viability of small-scale farming will drive existing farmer families out of business, which would create *issues around generational renewal of the farming sector* across the EU. At the same time, the increase in large-scale farming entails a demand for more skilled farmers and could lead to a more in highly trained and younger workforce and more attractive wages.

As the development and application of AI requires large amounts of data, lack of equal data access and sharing will have a significant *impact on market structure in agriculture*. It is likely to cement the power relationships that are unfolding now and accelerate the monopolisation tendencies of the sector. Large agricultural corporations work together with many small farmers and companies across economic sectors. They have more resources to invest in R&D, to collect enormous datasets or gain access to them, which makes it more difficult for smaller competitors to enter the market and operate in it.[71] Monsanto[72] and John Deere[73] provide prominent examples; they have equipped their agricultural machinery with sensors to collect data and build big data datasets. They offer access to these databases for their clients and app developers. This strategy not only drives the availability of innovative agricultural support services (which in the end benefits productivity), it also drives the sale of Monsanto and John Deere products. Agricultural manufacturing giants and industrial companies are constantly innovating and increasing productivity, at the expense of smaller farmers who risk going out of business.[74] It will further influence *competition and price structure*: economic behaviour of small farmers could become dependent from and strongly influenced by large seed conglomerates, to the disadvantage of consumers and smaller farmers themselves.[75]

2.1.2. Ethical AI will make difference by comparison to unfettered AI

Big data application in farming, such as described in the previous section, can generate valuable information, innovations and great efficiencies to the whole of the agricultural sector. However, unfettered AI applications may contribute to further deteriorate the competitive position of smaller, less wealthy farmers, as opposed to continuously consolidating and innovating large agri-businesses. In turn, this could increase consumer prices and affect EU food security. The market-driven AI development and deployment may lead to the continuous intensification of farming systems and practices and the 'pursuit of productivity and efficiency at the expense of the natural resource base, the sustainability of agriculture, traditional farming methods and family farms'.[76]

Digitisation of agricultural activities questions the need for a return to agricultural practices on a human and natural scale. 'Reluctance to accept the 'digital capture' of farming practices can be

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70 Schuh, B et al. (2019). Research for AGRI Committee – The EU farming employment: current challenges and future prospects, European Parliament, Policy Department for Structural and Cohesion Policies.

71 Burg, Simone van der, Marc-Jeroen Bogaardt and Sjaak Wolfert (2019). Ethics of smart farming: Current questions and directions for responsible innovation towards the future, NJAS – Wageningen. *Journal of Life Sciences* 90–91.

72 Carbonell, Isabelle M (2016). The ethics of big data in big agriculture. *Internet Policy Review* 5:1, p.5.

73 Hopkins, Matt (2016). John Deere Opens Data Platform To Other Software Suppliers .

74 Rundgren, Gunnar (2013). Why Competition in Agriculture is Unsustainable .

75 Kritikos, Mihalis (2017). Precision agriculture in Europe: Legal, social and ethical considerations. EPRS Study.

76 Ibid., p. 40.

understood as a resistance to the utilitarian perspective on agriculture and nature', based on economic efficiency and increased productivity models, and on the conceptualisation of the natural environment as a commodity.[77] Unfettered AI as expressed in precision agriculture does not seem to consider protection from exhaustion of natural resources and does not promote sustainable and multi-functional modes of agriculture that value biodiversity, water and soil quality and rural communities.[78] For instance, precision agriculture may help the reduction of the use of nutrients in specific types of agriculture but may have less to offer to reduce input-intensive and industrial farming.

Ethical framework for AI would provide guidance to find a balance between the economic gains of the technology and social and environmental benefits. Ethical AI development and application will shift the perspective from an almost exclusive focus on inputs and production to issues of industrial agriculture's externalities and vulnerabilities.

The introduction of innovative and expensive AI-powered hardware and software will create a new class of agricultural IP: data and knowledge about the farm itself. Smaller farmers lack resources to invest in R&D&I which may induce innovation that is ethically unacceptable and trigger the need for enforcing the concept of 'farmers' rights'. Cases exist[79] where large agricultural firms filed claims to prevent farmers from accessing, modifying or repairing big data software on their tractors creating a digital divide between the creators and actual users of the data. The data that farmers give technology providers put them in dependency and increases the influence and power of the latter over farmers. In such situations, farmers may be prone to manipulative abuse by agri-tech companies.[80] For instance, farmers may be forced to install hardware and software they do not actually need and they may be circumvent in decision-making about their own farm. They may be sharing more information and data than they would like to and are aware of.

Ethical framework for AI development and use could mitigate or even prevent such issues before they arise. While open-source tools and publicly funded research ensure access and control for a SMEs,[81] an ethical framework will help develop more individualised, targeted approach to AI development and use. Ethics change over time and across communities and would allow to contextualise the AI for the needs for the users. Depending on where an agricultural AI is deployed, it can be tuned to better reflect the priorities of the community (e.g. equity, just distribution, biodiversity).[82]

2.2. Telecommunications

Telecommunications (also known as electronic communications) sector encompasses economic activities related to conveyance of signals by electromagnetic means, such as by wire, radio, optical fibre, electricity cable via different networks (e.g. satellite networks, fixed networks including Internet, mobile terrestrial networks). Telecommunications refers solely to the transmission

77 Ibid., p. 44.

78 Ibid.

79 Carbonell, Isabelle M (2016). The ethics of big data in big agriculture. *Internet Policy Review* 5:1, pp. 2-3, 5-6.

80 Ryan, M. (2020). Agricultural Big Data Analytics and the Ethics of Power. *Journal of Agricultural and Environmental Ethics* 33, pp. 49–69.

81 Carbonell, Isabelle M (2016). The ethics of big data in big agriculture. *Internet Policy Review* 5:1, p. 7.

82 Burg, Simone van der, Marc-Jeroen Bogaardt and Sjaak Wolfert (2019). Ethics of smart farming: Current questions and directions for responsible innovation towards the future, NJAS – Wageningen. *Journal of Life Sciences* 90–91.

activities and excludes the generation or provision of content and other services that can be carries by the electromagnetic signal.

Most of the ethical issues [83] pertinent to the telecommunications industry have found their way into legislation and regulation,[84] and they are now legal as well as ethical issues:

1 Security, including cybersecurity: telecommunications are prone to various sector-specific types of crime (e.g. spam, phishing, hacking, malware, spyware, ransomware, virus) that lead to loss of personal data, leaks of important (e.g. confidential) information and cost millions in damages. With the increasing digitisation and reliance on telecommunication networks, cybersecurity has become Nr 1 ethical issue.
2 Privacy and data protection: telecommunications carry significant personal data that can be easily used to instantaneously identify and locate people. Data from all companies and all citizens always end up being transported via telecommunications networks. Considering the modern life being primarily lived online, telecommunications sector is at the frontlines of protecting our privacy and personal data.
3 Digital divide:[85] while some parts of the society are rushing ahead with ultra-speed internet and 5G networks, others struggle on narrow bandwidth or do not have internet or cell reception at all. Digital divide persists between countries (typically, North versus South), but is also present within countries, regions and even same localities; it is more prominent between urban and rural areas. The division between telecommunications haves and have-nots leads to disconnect in socio-economic development of countries and regions, underdevelopment of rural areas and directly impacts quality of life of individuals.
4 Net neutrality refers to equal treatment of all content and digital services. Telecommunications providers carrying the electromagnetic signals encoding content employ various tools to manage the transmission capacity on their network. If unregulated, telecommunications providers may prefer the traffic from those services that pay more.

[83] Brennan, Linda L., Victoria Elizabeth Johnson (eds) (2004). Social, Ethical and Policy Implications of Information Technology, Information Science Publishing; Sarikakis, Katharine; Rozgonyi, Krisztina (2016). Ethics in the governance of telecommunications: accountability of global industrial actors, 27th European Regional Conference of the International Telecommunications Society (ITS) 'The Evolution of the NorthSouth Telecommunications Divide: The Role for Europe', Cambridge, United Kingdom, 7th-9th September, 2016 .

[84] Key relevant legal acts are: Directive (EU) 2018/1972 of the European Parliament and of the Council of 11 December 2018 establishing the European Electronic Communications Code, OJ L 321 of 17.12.2018; Regulation (EU) 2015/2120 of the European Parliament and of the Council of 25 November 2015 laying down measures concerning open internet access and amending Directive 2002/22/EC on universal service and users' rights relating to electronic communications networks and services and Regulation (EU) No 531/2012 on roaming on public mobile communications networks within the Union, OJ L 310 of 26.11.2015; Regulation (EU) 2019/881 of the European Parliament and of the Council of 17 April 2019 on ENISA (the European Union Agency for Cybersecurity) and on information and communications technology cybersecurity certification and repealing Regulation (EU) No 526/2013 (Cybersecurity Act), OJ L 151 of 07.06.2019; Directive 2002/58/EC of the European Parliament and of the Council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector, OJ L 201 of 31.07.2002; Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC, OJ L 119 of 04.05.2016.

[85] Tavani, Hermann T. (2003). Ethical reflections on the digital divide. *Journal of Information, Communication and Ethics in Society* 1:2, pp. 99-108.

5 Corruption[86] is a specific sectoral problem related to public procurement activities (e.g. infrastructure projects) and frequency spectrum auctioning.

2.2.1. What shocks the AI use in telecommunications is likely to produce

The research by McKinsey Global[87] suggests that the potential economic value added by implementing AI technology to the global telecommunications sector to is worth US$521.6 billion (or 18.9 % of global sales), wherein advanced and traditional AI accounts for US$174.2 billion and US$347.4 billion respectively.

Telecommunications sector is an early adopter of technology, and the use of AI in telecommunications is likely to enhance the developments that are already underway assuring better quality of service. There are many AI-based improvements in telecommunications technologies and services. AI may lead to *better customer service* (e.g. virtual assistants using natural language processing), *smarter network deployment* due to data-based planning and design, and *development of new data-driven services*. There is a great demand for *autonomously driven network solutions and network optimisation*. For example, Self-Optimising Networks[88] automatically optimise network quality based on traffic and traffic prediction. Using machine learning and real-time analytics, these applications can reduce network congestions, improve network quality and, subsequently, enhance customer experience.[89]

AI applications can be deployed for physical *network maintenance.*[90] Using predictive maintenance or preventive maintenance techniques, telecommunications providers can monitor the state of their equipment and network parts (e.g. antennas, cell towers, powerlines, data centres) in order to act proactively or reduce diagnostics and repair times. With customers' permission, it is also possible to *monitor the end user side of the network* (e.g. modem use to identify WI-Fi issues) – with the aim to resolve technical problems and improve service.[91]

Robotic Process Automation (RPA) is considered a 'game changer' in the industry. It can be applied to tasks and processes that are structured and standardised. In telecommunications, RPA can automate back-end activities, like data entry, reconciliation and validation, billing, service assurance and others, *augmenting human effort* and thus *increasing accuracy and quality of these activities, reducing costs* and *freeing up human staff* for more complex, non-standard work.[92]

Telecommunications fraud is a wide-spread and growing problem, costing the industry between US$12 billion and up to 10 % of the operators' gross revenue.[93] AI-based filters and other software are being developed (and already used in some cases) to *detect fraudulent activity* on

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86 Wickberg, Sofia (2014). Overview of corruption in the telecommunications sector ; Transparency International (2015). Transparency in corporate reporting: Assessing the world's largest telecommunications companies 2015 ; Nygren, Birbitta and Mark Pyman (2020). Where are the voices of telecoms companies on anti-corruption? The FCPA Blog.

87 McKinsey Global Institute (2018): https://www.mckinsey.com/business-functions/mckinsey-analytics/our-insights/the-executives-ai-playbook?page=industries/telecom/# .

88 Churchill, Liad (2020). 4 areas where AI is transforming the telecom industry in 2019 .

89 Softengi (n.d.). AI for Telecom: Automatic, Adaptive, Autonomous.

90 Medium (2020). The Future of AI in the Telecom Industry.

91 Churchill, Liad (2020). 4 areas where AI is transforming the telecom industry in 2019 .

92 Ismail, Nick (2019). Robotic process automation in the telecommunications industry .

93 European Union Agency for Law Enforcement Cooperation (EUROPOL) and MicroTrend (2019). Cyber-Telecom Crime Report 2019, p. 6.

telecommunications networks.[94] Machine learning and natural language processing systems analyse patterns in text messages (e.g. chats, emails, SMS) and voice calls and can intercept and entirely block them or warn the user if the patterns diverge from normal. AI applications can also check the veracity of messages and calls in real-time (e.g. brand names mentioned, addresses and locations, URLs, inspect reviews and complaints online) and give a warning or suggestion to the user.

Europe's leading telecommunications providers are already providing trusted data spaces for customers, investing in partnerships with universities and research centres, adapting ethical frameworks to their own use of AI,[95] and using AI to better plan and run networks. However, some issues around data privacy and transparency as well as the use of customer data to 'optimise' telecom services remain unresolved.

2.2.2. Ethical AI will make difference by comparison to unfettered AI

Due to the amounts of data transferred through telecommunications networks and the sensitivity of those data, the development and use of ethical AI applications is likely to be costly for the sector. On top of this, the cybersecurity requirements to telecommunications networks are also very high, which is likely to increase the cost. On the other hand, the necessary high ethical standards are mostly incorporated in the legal framework and standardisation (and likely in certification later), which means that no big differences can be expected between unfettered AI and ethical AI in the context of telecommunications.

2.3. Transport

The transport sector encompasses a variety of economic activities related to moving of passengers and freight by different means (e.g. by road, railways, waterways and air). The modes of transport are often considered its sub-sectors.[96] This section focuses primarily on the road transport.

Ethical issues in transport concentrate around the following topics:[97]

1. Environmental impacts include adverse impacts of transport on air quality, deterioration of natural habitats and biodiveristy, as well as noise pollution. In addition, they are often unequally distributed across locations as some neighbourhoods are more affected by high volume of transport. Environmental impacts also endanger human health, whose intensity also varies differently depending on where people live. Environmental impacts (can) include sustainability issues of transport, including the reliance on fossil fuels.
2. Accessibility and inclusion: availability of transport connections and their affordability are important for socio-economic life. Currently access to e.g. public transportation is unequal due to planning and economic considerations: in some

94 Zhao, Qianqian, Kai Chen, Tongxin Li and Xiaofeng Wang (2018). Detecting telecommunication fraud by understanding the contents of a call. *Cybersecurity* 1:8; Dada, Emmanuel G., Joseph Stephen Bassi, Haruna Chiroma, Shafi'i Muhammad Abdulhamid, Adebayo Olusola Adetunmbi, Opeyemi Emmanuel Ajibuwa (2019). Machine learning for email spam filtering: review, approaches and open research problems. *Heliyon* 5:6; Cjaudhary, Manuyash (2020). Spam SMS detection using Machine learning .

95 European Telecommunications Network Operators' Association (ETNO) (2019). Trustworthy AI: EU recommendations send strong political signal .

96 See Eurostat's sectoral analysis of transportation and storage statistics: https://ec.europa.eu/eurostat/statistics-explained/index.php/Transportation_and_storage_statistics_-_NACE_Rev._2#Sectoral_analysis .

97 Anciaes, Paulo Rui and Nikolas Thomopoulos (2-14). Ethical issues in transportation. In: Mark Garrett (ed.) Encyclopedia of Transportation: Social Science and Policy. SAGE Publications, Thousand Oaks, California, USA, pp. 534-541.

communities, a personal vehicle is indispensable for people to be able to go to work, hospital, school or shopping. Access to transport may be especially unequal for the most vulnerable groups: elderly, poor, less mobile people (i.e. includes both disabled, their careers and e.g. young mothers with children). Inclusion has an aspect of affordability to it: vulnerable groups may be excluded due to high price of transportation.

3 Safety: this complex issue includes safety of vehicles, safety of passengers (e.g. safety belts, anti-lock braking system, crash safety) and safe use of vehicles by passengers (e.g. driving by elderly drivers, drunk driving). With the development of autonomous cars, the aspect of cybersecurity is added to this list: vehicles need to be safe from hacking, bugs, software malfunction etc.

4 Privacy and personal data protection:[98] both the cars and public transport infrastructure already collect significant amounts of data that are personalised (e.g. engine identification number, car plates, RFID for toll collection, CCTV cameras). The amount of personal data collected is only going to increase with the development and adoption of autonomous vehicles. While these data may often be used to improve on other ethical, societal etc issues, the collection and processing of these data are of utmost concern as they may lead to discriminatory practices, surveillance and violation of privacy.

5 Liability and responsibility for accidents: this important issue gains in significance with the development of assisted driving and autonomous vehicles. It is currently not clear how the moment of human-to-machine interface and handover procedures should be handled and how the problems of software versus hardware liability interplay with the liability for faults in the transport and communication infrastructure.

6 Employment: this includes both the labour force and the working conditions in the sector. Labour force in transport is dwindling, at the same time, it is expected that automation compensate for some of it. Working conditions in transport are notoriously poor, including low wages, health and safety hazards (e.g. working hours, resting arrangements), work culture.

2.3.1. What shocks the AI use in transport is likely to produce

The McKinsey Global Institute estimates[99] that the potential global added value of implementing AI-technology in the transport and logistics sector is worth US$977.6 billion or approximately 13 % of global sales. Traditional AI and analytics are predicted to account for US$502.8 billion, whilst advanced AI and analytics, such as deep learning neural networks, will be worth US$474.8 billion.

With AI applications in transport, it is expected that social differences in mobility and accessibility levels may be influenced in different ways. AI used for *planning of transportation networks* may suggest or promote biased investment decisions in relation to transport infrastructure and networks, for instance, based on historical data and when driven only by efficiency. Private operators of public transportation may lack incentives to serve areas with small demand, which would increase

[98] Steinfeld, Aaron (2010). Ethics and Policy Implications for Inclusive Intelligent Transportation Systems. Paper presented at the Second International Symposium on Quality of Life Technology, Las Vegas, USA .

[99] McKinsey Global Institute (2018): https://www.mckinsey.com/business-functions/mckinsey-analytics/our-insights/the-executives-ai-playbook?page=industries/transport-logistics/ .

cost of transportation. All this would cause *accessibility problems for rural and suburban areas* affecting job opportunities and household income.[100]

However, AI applications will fully enable and render *efficient carpooling and carsharing* services that would increasing mobility options for rural travellers who are currently reliant only the car or public transport as their sole means of transportation.[101] Similar trends are likely to develop in the air transport[102] where passengers often face the problem of *flight delays* that in 2018 cost 17.6 billion euro for the European economy, according to Eurocontrol.[103] Additionally, flights delay negatively impact passenger's flying experience, which in turn can undermine a transport company's value.

Furthermore, *traffic management* through AI can help solving traffic congestion, reduce related accidents and wasted transportation time faced by many urban commuters. However, as such technology is likely to be reliant on cameras 'embedded everywhere on roads that collect a large voluminous amount of traffic details', issues of data-privacy may hamper the incentive for market-investments in such technologies.[104]

As AI will enable *fully autonomous driving (driverless cars)*, the previously excluded or under-served categories (e.g. persons with disabilities, older adults) will enjoy improved mobility and accessibility of transport, allowing them to access workplaces and thus generate income.[105] At the same time, the adoption of the connected and automated vehicles (CAV) will *endanger the jobs of low-skilled workers* in freight and passenger transport (i.e truck and taxi drivers), and it is likely to hit hardest those aged 40-60.[106] However, problems for transport workers have already started now and will be aggravates in the near future, with the development and adoption of CAV. With continuing development of *Mobility-as-a-Service (MaaS)* enabled by AI, more people will become drivers employed or, rather, contracted by MaaS companies, which would have positive impact as an additional source of income. Yet, such companies refuse to classify workers as employees *depriving them of worker protection and social benefits* (e.g. minimum wage, insurance), while at the same time saving a lot of overhead costs and increasing corporate revenues.[107] The MaaS workers do not have the bargaining power of payroll employees such that MaaS may also account for *slowing wage growth*.[108]

The job loss in the transport sector caused by the deployment of CAV will have implications on other sectors: for instance, as fewer bus and taxi drivers are employed by municipalities, also fewer civil servants will be needed in traffic departments, city planning, traffic police and other public departments. At the same time, new jobs will be created that require new skills (e.g. data and

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100 Anciaes, Paulo Rui and Nikolas Thomopoulos (2-14). Ethical issues in transportation. In: Mark Garrett (ed.) Encyclopedia of Transportation: Social Science and Policy. SAGE Publications, Thousand Oaks, California, USA, p. 540.

101 Datson, James (2017). The importance of data in MaaS. *Intelligent transport*.

102 Joshi, Naveen (2019). How AI Can Transform the Transportation Industry. *Forbes*.

103 Mulligan, John (2019). Europe's flight delays cost €100 a minute. *Independent*.

104 Joshi, Naveen (2019). How AI Can Transform the Transportation Industry. *Forbes*.

105 German Federal Ministry of Transport and Digital Infrastructure. Report by the Task Force on Ethical Aspects of Connected and Automated Driving. Ethics Task Force. June 2018.

106 Surakitbanharn, Caitlin A., Mikaela Meyer, Baylee Bunce, Jackson Ball, Christina Dantam, and Roshini Mudunuru (2018). Preliminary Ethical, Legal and Social Implications of Connected and Autonomous Transportation Vehicles (CATV). Purdue Policy Research Institute, p. 21.

107 Compo, Jonathan (2019). Pay to Play (And Work): Uber's Insidious Exploitation. *The Pavlovic Today*.

108 Akhtar, Allana (2019). Gig-economy workers like Uber and Lyft drivers may be skewing low unemployment numbers. *Business Insider France*.

computer scientists in mobility service providers and control centres for CAV).[109] Although such developments are positive for high-skilled workers, they will drive a down-turn in income of low-skilled workers who cannot be re-trained or re-educated, at least in a short to medium term. This will widen the income gap in the society.

MaaS would allow transportation to become truly *intermodal*, due to better data sharing between different modes of transport and superior transport planning.[110] In turn, this will impact transportation choice of consumers who may decide for more environmentally friendly transport types or to use them more frequently once their usage is made more convenient by AI. AI algorithms supporting MaaS calculate the number of requests at any given point and equate it with the number of vehicles available taking into account other environmental and traffic conditions: congestion, road works, weather, events, etc. With the availability of the personal data of the client, they may also take into account age, disability, location, past behaviour and other conditions and preferences. This opens opportunities for *contextualisation and individualisation of transport services and prices,*[111] which may be unethical at the very least (e.g. prices going up in bad weather or in case of emergency) and discriminatory at worst (e.g. if a person needs a ride to what can be considered dangerous neighbourhood).

As the transition to CAV and MaaS will increase accessibility of transport for more new users, it is also likely to increase the number of trips in general and, therefore, *intensify the usage of transport infrastructure*. Due to the ease of travelling and more pleasant travelling experience, people are likely to undertake *more and longer trips*. The number of empty trips will grow as well, as CAV will have to move from assignment to assignment and to parking. The more intense usage of the infrastructure will result in higher maintenance costs. At the same time, the shift to low and zero emission CAV, decreasing car ownership, fewer traffic violation and less parking fees will probably *reduce public revenues that are used to finance infrastructure.*[112]

2.3.2. Ethical AI will make difference by comparison to unfettered AI

The impacts of both AI in general and ethical AI specifically in the transport sector are expected to be substantial. The European Commission has listed transport as a 'high risk' group with regards to the implications of AI technology – both on the basis of individuals as well as companies.[113] In the context of ethical AI in transport, it might be more difficult to access data, in particular if it is sensitive, which may be required in large volumes for effective functioning of CAV. On the other hand, data protection allows for the safety management and control of the access to automated vehicle (data) by third parties, which assures higher levels of safety for the vehicle, its passengers, as well as other traffic participants. In aviation, widening the use of ethical AI cannot take place until the protection of personal data, which is linked to using automated aircraft, is assured. In maritime, similarly to other sectors, broad AI use will have to be preceded by well-defined data ownership and

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109 Tschiesner, Andreas (n.d.). How cities can benefit from automated driving.

110 Goodall, Warwick, Tiffany Dovey Fishman, Justine Bornstein and Brett Bonthron (2017). The rise of mobility as a service: Reshaping how urbanites get around. Deloitte Insights; Medium (2019). MaaS or the New Mobility Paradigm!
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111 Sen, Sunny (2016). All you need to know about Ola, Uber surge pricing in 5 points. *Hindustan Times*; Goodall, Warwick, Tiffany Dovey Fishman, Justine Bornstein and Brett Bonthron (2017). The rise of mobility as a service: Reshaping how urbanites get around. Deloitte Insights; International Association of Public Transport (UITP) (2019). Mobility as a service.

112 German Federal Ministry of Transport and Digital Infrastructure. Report by the Task Force on Ethical Aspects of Connected and Automated Driving. Ethics Task Force. June 2018, p. 19.

113 Dignum, Virginia, Catelijne Muller and Andreas Theodorou (2020). First analysis of the EU White paper on AI.

accessibility rules. Also, the rights of certain data controllers must be set up in a way that does not lead to the formation or enhancement of monopolies.[114]

As noted above, the use of unfettered AI in planning of transportation networks may reinforce existing biases and exacerbate the lack of access to transport and negative environmental effects on already disadvantaged neighbourhoods.[115] If AI applications are driven only by efficiency and do not account for social and environmental factors, rural and suburban areas may remain underserved and some communities will continue suffering higher air and noise pollution.

The individualisation of transport services and prices[116] is driven purely by market forces may result in unfair treatment and discrimination of individual users and victimisation of neighbourhoods (e.g. ride fees higher for certain neighbourhoods). An ethical framework for AI could control for biased decision-making in this context and ensure that service is personalised (i.e. caters to individual needs) without being discriminatory or exclusionary.

2.4. Automotive industry

The automotive industry covers economic activities of manufacturing motor vehicles and is, therefore, closely related to the transport sector. The automotive is a critically important sector for the EU, with many world-class car makers responsible for about 6 % of total EU employment. The sector is also the largest private investor in R&D&I contributing to European competitiveness and technological leadership.[117]

Ethical issues in the automotive are (inter)related to those in the transport sector:

1. Environmental impact: conventional vehicles pollute the environment considerably due to their use of fossil fuels. Humans are not efficient drivers, struggling to maintain constant speed, braking unnecessarily and not able selecting shorter routes – all of which is exacerbated by suboptimal traffic conditions. The demand for car ownership drives the manufacturing that is also harmful for environment.
2. Affordability of CAV and technological divide*:* higher costs for automated vehicles will make them affordable for those with medium to high income and also to larger enterprises (at least in the short to medium term).[118] As a result, the divide between those who can reap the new technologies' benefits and who is left behind will further increase.
3. Trust and control*:* this issue refers to users having trust in CAV and their producers. By using CAV, users are actively relinquishing the control over many decisions – not

[114] Niestadt, Maria, Ariane Debyser, Damiano Scordamaglia and Marketa Pape (2019). Artificial intelligence in transport: Current and future developments, opportunities and challenges. EPRS briefing, p. 11.

[115] Anciaes, Paulo Rui and Nikolas Thomopoulos (2-14). Ethical issues in transportation. In: Mark Garrett (ed.) Encyclopedia of Transportation: Social Science and Policy. SAGE Publications, Thousand Oaks, California, USA, p. 540.

[116] Sen, Sunny (2016). All you need to know about Ola, Uber surge pricing in 5 points. *Hindustan Times*; Goodall, Warwick, Tiffany Dovey Fishman, Justine Bornstein and Brett Bonthron (2017). The rise of mobility as a service: Reshaping how urbanites get around. Deloitte Insights ; Medium (2019). MaaS or the New Mobility Paradigm!; International Association of Public Transport (UITP) (2019). Mobility as a service .

[117] See data at the European Commission’s website: https://ec.europa.eu/growth/sectors/automotive_en .

[118] Surakitbanharn, Caitlin A., Mikaela Meyer, Baylee Bunce, Jackson Ball, Christina Dantam, and Roshini Mudunuru (2018). Preliminary Ethical, Legal and Social Implications of Connected and Autonomous Transportation Vehicles (CATV). Purdue Policy Research Institute, pp. 17-20.

only about driving itself but also about their own health and safety and those of other traffic participants.

4 Privacy and data protection: as the technology for enhanced user experiences (e.g. effective routing, route-mapping) to varying extents often requires personal/sensitive data from its user (e.g. location, navigation patterns), issues with data protection and privacy arise.

2.4.1. What shocks the AI use in automotive is likely to produce

Market prediction by McKinsey Global Institute claims[119] that traditional AI will account for US$459.7 billion in potential economic value for the global automotive and assembly sector, whilst advanced AI and analytics will result in further US$406.1 billion. In total, the application of AI to the sector is predicted to amount to an 8.6 % of sales (using 2016 global figures), which equals to US$865.8 billion.

The Future of Work Community reports that 'by adjusting routes based on real-time traffic data, self-driving vehicles can alleviate traffic congestion and reduce gas needs, saving employers an estimated 42.3 trillion dollars a year by 2035'.[120] According to another study by McKinsey, 'autonomous vehicles will be driving around our towns and cities from 2030 onward' and 'projections indicate they will significantly outweigh non-autonomous vehicles between 2040 and 2050,' accounting for an estimated 90 % of all journeys in cities.[121] *While traffic violations will decrease* dramatically with the introduction of CAV, the *municipal income from parking and speeding tickets will drop*, which is likely to have impact on infrastructure and other spending (as noted in section 1.5.3).[122] At the same time, with fewer accidents, the need and, therefore, the cost of emergency services will decrease – as well as associated costs of healthcare. Additionally, it is estimated that '1 billion euros additional income can be created in the EU if half of all driving time can be utilized productively'.[123]

The costs of CAV are expected to be substantial especially during their early introduction, when compared to non-automated vehicles, and they will likely only be affordable for middle- and high-income consumers.[124] This will further *widen the gap in access to and enjoyment of benefits of technology* between low-income and high-income consumers, while poorer people actually stand to benefit of the technology.[125] This may also create country-level divides and market centralisation, as wealthier countries (e.g. the Nordics, Germany, the Netherlands) will provide a larger consumer-

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119 McKinsey Global Institute (2018): https://www.mckinsey.com/business-functions/mckinsey-analytics/our-insights/the-executives-ai-playbook?page=industries/automotive-assembly/ .

120 Joshi, Naveen (2019). How AI Can Transform the Transportation Industry. *Forbes*.

121 Tschiesner, Andreas (n.d.). How cities can benefit from automated driving .

122 For instance, Hamburg has annual 30-million-euro flows from traffic fines, and Stuttgart gets about 11 million euros from speeding tickets, see Tschiesner, Andreas (n.d.). How cities can benefit from automated driving .

123 Ibid .

124 Bösch, Patrick M., Felix Becker, Henrik Becker, and Kay W. Axhausen (2018). Cost-based analysis of autonomous mobility services. *Transport Policy* 64, pp. 76-91.

125 The research shows that poorer people are more likely to die in road accidents because they often drive older cars that lack safety features. See Harper, Sam, Thomas J. Charters, Erin C. Strumpf (2015). Trends in Socioeconomic Inequalities in Motor Vehicle Accident Deaths in the United States, 1995–2010, *American Journal of Epidemiology* 182: 7, pp. 606–614.

base than other EU member states (e.g. Italy, Spain, the Balkans), making it more lucrative for automotive producers to focus on the markets pertaining to the former group of countries.[126]

To ensure *safety of CAV* and gain *consumer trust*, the costs of R&D and testing are likely to grow – as well as administrative and compliance costs associated with standards and certification. While human drivers accept very high risks of personal injury or even death on the road – their own or other traffic participants, they require much higher safety and security standards from AI.[127] This seems to be linked to human being uncomfortable with relinquishing control and decision-making power to AI. As a result, automotive manufacturers will be apprehensive to implement AI solutions if they stand to lose consumer trust (and ultimately costumers). The rising financial and reputational risk of damage claims will be met by more rigorous research and testing as well as expensive marketing campaigns.

CAV are predicted to annihilate or *reduce the ecological and environmental burden* significantly due to more efficient driving and the ability to program shorter routes and. AI-based systems for effective routing allows passengers to reach their destination in a shorter period of time and distance, thereby reducing the emission of greenhouse gasses and number of cars on the road.[128] Congestion on the road will virtually disappear, further reducing emissions caused by stop-and-go traffic. Although the scale of reduction will be minimal until CAV amass a larger market share and customer base, the dropping need for oil-based combustibles will likely have an effect on another sector, namely (non-renewable) energy.

However, researchers have suggested that the *positive environmental effects of CAV may be offset* by the carbon footprint resulting from the associated R&D&I and policy and legal requirements. The development and training of AI applications is not only expensive, it is also polluting. The life cycle assessments of some common AI models revealed that the process emits up to '626,000 pounds of carbon dioxide, equal to nearly five times lifetime emissions of an average American car including its manufacture'.[129] The environmental costs of training AI grow exponentially if more tuning steps are added, while performance increasing only incrementally.

The positive environmental effects of CAV are also likely to be offset by *behavioural changes* that they will induce.[130] CAV are predicted to offer superior travelling experience freeing time for passengers to engage in activities other than driving. They will also allow currently under-served populations (e.g. elderly, children, people without a driving licence) to take up independent trips. The number of cars in total is likely to increase as people may shift from public transport to individual vehicles because public transport (including trains and airplanes) will not offer its unique benefits

[126] Capgemini (2019). Accelerating automotive's AI transformation: How driving AI enterprise-wide can turbo-charge organizational value ; Bird, Eleanor, Jasmin Fox-Skelly, Nicola Jenner, Ruth Larbey, Emma Weitkamp and Alan Winfield (2020). The ethics of artificial intelligence: Issues and initiatives. STOA Study, p. 29.

[127] Surakitbanharn, Caitlin A., Mikaela Meyer, Baylee Bunce, Jackson Ball, Christina Dantam, and Roshini Mudunuru (2018). Preliminary Ethical, Legal and Social Implications of Connected and Autonomous Transportation Vehicles (CATV). Purdue Policy Research Institute, pp. 30-33.

[128] Williams, Alice (2017). How AI in cars will affect the environment .

[129] Hao, Karen (2019). Training a single AI model can emit as much carbon as five cars in their lifetimes. *MIT Technology Review* .

[130] Erickson, Jim (2019). U-M study: 'Induced' driving miles could overwhelm potential energy-saving benefits of self-driving cars. *University of Michigan; Michigan News*.

any more (e.g. no driving fatigue, having leisure time while on the road, less time in traffic).[131] All this will lead both to more trips and longer trips, such that CO2 'saved' due to efficiency of vehicles will be still emitted due to the increased use.

2.4.2. Ethical AI will make difference by comparison to unfettered AI

While an ethical framework for development and deployment of AI in vehicles will not solve some of the negative consequences of digitisation (e.g. environmental effects caused by changing behaviours of consumers), it is likely to mitigate others. Transparency and clarity about the algorithm training and decision-making in the dilemma-based situations (like the famous trolley problem) will increase public/ consumer trust in AI technologies.[132] Having a public consultation about moral dilemmas in application to CAV and relying on democratic representative institutions formulating applicable frameworks – instead of private proprietary solutions – could ensure wider acceptance and enjoyment of CAV benefits.[133]

An ethical framework is necessary to ensure privacy and data protection of the user and to help resolve complex issues around data use by CAV. CAV will be able to collect and use huge amounts of data because vehicles need to be aware of themselves and their surroundings. At the very minimum, CAV will need data on itself and its systems, its actions, its surroundings including neighbourhoods and other vehicles, its users, their locations, habits and possibly even their state (e.g. whether an intoxicated user is trying to assume control of the vehicle, whether the user requires medical assistance). An ethical framework will guide legislative decisions about what data are actually necessary for the optimal functioning of CAV, where they can be processed, who should have access to these data (e.g. CAV manufacturer, transport department, police, other third parties) and under what conditions, and it will ensure interoperability of AI systems.[134]

To ensure that the benefits of AI technology are equally shared across the society, ethical considerations need to be part of the development and deployment policies.[135] Universal design should be incorporated in CAV that accommodates people with special needs and abilities. Affordability should be at the forefront of thinking such that CAV solutions are available to individuals and communities who need them most. Ethics can also help balance community interests versus individual interests (e.g. CAV programmed to protect life and health of passengers may increase risk of accident for other traffic participants).

At the same time, as indicated above, ethical AI applications are likely to be much more expensive and have a higher carbon footprint than unfettered AI due to the additional research and training that it would require.

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131 Surakitbanharn, Caitlin A., Mikaela Meyer, Baylee Bunce, Jackson Ball, Christina Dantam, and Roshini Mudunuru (2018). Preliminary Ethical, Legal and Social Implications of Connected and Autonomous Transportation Vehicles (CATV). Purdue Policy Research Institute, p. 34.

132 Smith, Bryant Walker (2020). Ethics of Artificial Intelligence in Transport. In: Markus Dubber, Frank Pasquale & Sunit Das (eds.) The Oxford Handbook of Ethics of Artificial Intelligence (forthcoming), p. 12:.

133 German Federal Ministry of Transport and Digital Infrastructure. Report by the Task Force on Ethical Aspects of Connected and Automated Driving. Ethics Task Force. June 2018, pp. 9-13.

134 Surakitbanharn, Caitlin A., Mikaela Meyer, Baylee Bunce, Jackson Ball, Christina Dantam, and Roshini Mudunuru (2018). Preliminary Ethical, Legal and Social Implications of Connected and Autonomous Transportation Vehicles (CATV). Purdue Policy Research Institute, pp. 3-5.

135 Litman, Todd A. (2020). Autonomous vehicle implementation predictions: Implications for transport planning. Victoria Transport Policy Institute.

2.5. Construction

The construction sector covers manufacture and trade activities related to building, maintaining and repairing various structures, such as buildings (residential, industrial and commercial) and other facilities (bridges, roads, tunnels, airfields etc.).

Ethical issues facing the construction sector[136] lie both on the side of the contractor and on the side on the client.[137] For *contractors*, we can identify the following issues:

1. Sustainable (ecological) construction methods refer both to the design, building phase (e.g. materials used, waste management) and to the use of the completed building and later phases of its existence (e.g. energy consumption, building convertibility, maintenance, healthy design).
2. Ethical partnerships (or management of sub-contractors and suppliers): the usage of sub-contractors in construction sector is huge, and the treatment of sub-contractors raises a lot of questions. This is linked both to the adherence of sub-contractors to the same socio-ethical norms as the main contractor and to rights of the sub-contractor and its staff (e.g. payment and working conditions).
3. Treatment of construction workers: working conditions and workers' rights are a huge problem in the construction industry. They range from inadequate worker accommodation and work safety to low wages (especially for migrant workers) and on time payments.[138]
4. Corruption:[139] payment of bribes for permits, licences and inspections and employing workers illegally[140] (i.e. not paying social payments and taxes, employing workers without working permits), rigged procurement procedures and price fixing are frequently reported problems.

For *construction clients*, the following issues are major:

136 Valtonen, Heimo and Mikko Nousiainen (2005). Promoting ethical principles in construction and real estate business. Paper presented at the 2005 World Sustainable Building Conference, Tokyo, 27-29 September 2005. Ethical Advocate (2019). Does the Construction Industry Have an Ethics Dilemma?.

137 Netscher, Paul (2017). Ethics in Construction. What are unethical behaviours? Why should we care? ; Shah Raj K. and M. Alotaibi (2018). A study of unethical practices in the construction industry and potential preventive measures. *Journal of Advanced College of Engineering and Management* 3, pp. 55-77.

138 European Trade Union Institute (ETUI) (2016). Construction workers at the mercy of social dumping. *HesaMag* #13; Andrew Dainty, Stuart Green, Barbara Bagilhole (eds.) (2007). People and Culture in Construction: A Reader. Taylor & Framcis.

139 PricewaterhouseCoopers (2014). Fighting corruption and bribery in the construction industry. Engineering and construction sector analysis of PwC's 2014 Global Economic Crime Survey; Locatelli, Giorgio, Giacomo Mariani, Tristano Sainati and Marco Greco (2017). Corruption in public projects and megaprojects: There is an elephant in the room! *International Journal of Project Management* 35:3, pp. 252-268.

140 Cremers, Jan, Colin C. Williams, Jo Hawley Woodall and Nataliya Nikolova (2017). Tackling undeclared work in the construction industry: A learning resource from the Construction Seminar of the European Platform Undeclared Work.

1. Corruption: linked to the above, n the client side, this issue mainly refers to rigged procurement procedures (e.g. awarding contracts to bids with too low prices, pushing prices down).
2. Low morals in relation to payments and contracts: clients frequently refusing to pay full prices and not paying on-time.

2.5.1. What shocks the AI use in construction is likely to produce

To begin with, we should note that the construction industry is chronically *under-digitised* and does *not invest enough in R&D.*[141] So, any digitisation is likely to bring huge benefits. At the same time, it is expected[142] that AI applications will be possible across the complete value chain in construction, from design and planning, through to building processes (including building materials), down to post-construction.

AI applications will significantly *improve construction project management.*[143] While each construction project is unique and requires a lot of upfront planning and there is often lack of standardisation, AI would allow to make the planning more detailed and enhance predictability of projects due to superior forecasting. AI applications can factor in weather conditions, supply levels and progress, regulatory requirements, labour situation and schedules and other variables to come up with more precise management. This would make *costing of projects more accurate* and prevent cost overruns. AI can help to plan the *execution of the project* better[144] because about one third of the time on construction sites is spent on rearrangements, search for materials, transport and downtime. This should *increase productivity and save costs*. AI-based *optimisation of materials management*[145] will also help with *supply chain management and inventory management*. Improved project management also includes *improved contract management*, which is currently a big challenge for construction SMEs. All this will improve *risk management and project monitoring*.

AI-powered image recognition, combined with sensors and big data analytics, will be able to conduct *automated real-time safety audits*[146] and improve the compliance and safety of construction site. In addition, this safety monitoring is likely to improve the quality of the final building. Accidents are frequent on construction sites[147] and are a major source of overruns.[148] With the construction sector being responsible for more than 10 % of non-fatal and 20 % of fatal accidents at work in the EU, the sector experiences huge losses in productivity, administrative and insurance costs while

141 EURACTIV (2019). Digitising the EU's construction industry. Manifesto report; see also https://www.euractiv.com/section/digital/special_report/digitising-the-eus-construction-industry/ .

142 Schober, Kai-Stefan (2020). Artificial Intelligence in the construction industry. How to increase efficiency over the entire lifecycle chain. Roland Berger research .

143 Chatterjee, Shuvashish (2019). Re-Imagining future of construction with AI. *Towards Data Science* .

144 Schober, Kai-Stefan (2020). Artificial Intelligence in the construction industry. How to increase efficiency over the entire lifecycle chain. Roland Berger research.

145 Blanco, Jose Luis, Steffen Fuchs, Matthew Parsons, and Maria João Ribeirinho (2018). Artificial intelligence: Construction technology's next frontier .

146 Chatterjee, Shuvashish (2019). Re-Imagining future of construction with AI. *Towards Data Science*.

147 Eurostat (2019). Accidents at work statistics in 2017 .

148 Schober, Kai-Stefan (2020). Artificial Intelligence in the construction industry. How to increase efficiency over the entire lifecycle chain. Roland Berger research; Bahra, Amandeep (2019). What causes delays and cost overruns on major infrastructure projects?

workers and their family suffer significant healthcare and quality of life deterioration.[149] AI applications are likely to help reducing the direct and indirect costs and to preserve workers' health.

AI applications in the area of *photogrammetry* (computer application for *land surveying and inspection*)[150] can both improve and save costs for the very work and time intensive pre-design phase. The design phase will benefit from a greater use of *3D modelling (BIM)* that can be further enhanced by AI, even for complex tasks like plumbing and electrical works.[151] The industry can use *generative design*[152] powered by machine learning to identify and manage clashes between different plans and models created by different teams/streams of work (e.g. plumbing, electrical).

All the above applications should help address the *labour shortages* in the industry.[153] AI applications can better assess the labour supply and plan work accordingly. Drones and construction robots may assist humans in some of the tasks (e.g. bringing tools and materials).[154] There is a potential for better, *personalised training for construction workers and apprentices* that, at the same time, would allow to save cost. Done or assisted by AI, it can be more individualised including language skills and level of experience/ knowledge.

2.5.2. Ethical AI will make difference by comparison to unfettered AI

Ethical framework for AI applications in construction is likely to have a decisive impact for a greater transparency of the industry and address corruption and other unethical and illegal practices. Digitisation in general, data analytics and AI will help disentangle complex transaction chains that help hide costs. It will become easier compare different projects and stages of projects both for the builder and the client and to make more accurate predictions about the duration and cost of works. AI can help navigate the complicated permit procedures and, once they all are digitised, fewer possibilities for bribes will remain. An ethical framework will set conditions for the availability of the documentation and information on the project for third parties and it could also foresee how projects and costs can be replicated or audited to check all numbers.

Because the construction sector has a large number of SMEs that lack financial resources and skills, an ethical framework would be necessary for AI deployment in order to ensure that all sector participants reap benefits of the new technology and it does not get monopolised by a handful of big companies. This refers primarily to data sharing and access along the whole supply chain. Big data analytics, blockchain and AI will enable better information on pricing, costs, timing and progressing of projects throughout the whole supply chain. Yet these technologies should be used not only by big contractors to survey and control their sub-contractors, but also by subcontractors to monitor timely payments from contractors. Ethical principles would guide the use of AI in the interest of the industry as a whole – main contractors, sub-contractors and clients – from the start of the project.

Unfettered AI will solve many efficiency issues of project and contract management and reduce corruption in the industry and procurement. However, an ethical framework needs to be added to deal with sensitive data. In the construction sector, the important ethical issues are likely to be what

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149 Weerd, Marjolein de, Rory Tierney, Birgit van Duuren-Stuurman, and Evelina Bertranou (2014). Estimating the cost of accidents and ill-health at work. Study for OSHA.

150 Chatterjee, Shuvashish (2019). Re-Imagining future of construction with AI. *Towards Data Science*.

151 Hepton, James (2019). The future of AI in the construction industry .

152 Rao, Sumana (2019). The Benefits of AI in Construction .

153 CEDEFOP (2015). Skill shortages and gaps in European enterprises. Cedefop reference series 102 ; Darvas, Zsolt and Ines Goncalves Raposo (2018). The ever-rising labour shortages in Europe .

154 Rao, Sumana (2019). The Benefits of AI in Construction .

data should be available to the procurer and assessed by him/ her, what data should remain confidential, like trade secrets, know-how and designs protected by intellectual property rights.

2.6. Energy

The energy sector convers all activities involved in the production and sale of energy, from fuel extraction (e.g. gas, oil) and production (e.g. wind, solar, biofuels) to refining, transportation and distribution to industrial and private consumers.

The ethical issues in the energy sector[155] can be divided into three categories based on what end they sit: production, distribution and consumption.[156] The ethical discussion revolves around three questions: who participates, who benefits and who bears the burden.

In terms of *production*, the ethical issues raised are linked to how energy is extracted and produced:

1. Sustainability of energy sources[157] refers to the depletion of fossil fuels and use of renewable energy, but also to historic and current responsibility for CO2, ways of transitioning to sustainable energy (e.g. technology) and who should pay for this.
2. Environmental risks of energy sector (precaution and environmental responsibility): oil and gas production, especially fracking, but also uranium mining and coal mining through mountaintop removal involved significant risks due to toxic chemicals' use, water contamination, irreversible environmental degradation and destruction of ecosystems.
3. Relocation, destruction or traumatisation of whole communities[158] are often necessary precursors of energy extraction and production. They are accompanied by the destruction of landscapes and historical and cultural sites.
4. Externalisation of the costs of energy production: the costs are not paid by the industry or by consumers, but simply left for future generations (e.g. storage of radioactive uranium waste).

On the *distribution* side, ethical issues arise even for renewable energy:[159]

1. Equality (access to energy) has many facets. It includes the problem of energy poverty both for communities and for individuals. This may also include the problem that not all communities and individuals have access to sustainable energy. It also includes the price of energy (i.e. too high prices are a barrier to access), which may result in discrimination of individuals or groups.

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[155] Kimmins, James and Marcia Lord (2001). The ethics of energy: A framework for action. Programme document for the World Commission on the Ethics of Scientific Knowledge and Technology.

[156] Luppala, Linnea (2016). Is energy an ethical issue? Energy Futures Lab.

[157] Miller, Clark (2014). The ethics of energy transitions. *2014 IEEE International Symposium on Ethics in Science, Technology and Engineering, ETHICS 2014*, Institute of Electrical and Electronics Engineers Inc.

[158] To provide just a few examples: Short, Damien and Anna Szolucha (2019). Fracking Lancashire: The planning process, social harm and collective trauma. *Geoforum* 98, pp. 264-276; Arbinolo, Roberta (2020). Heritage under siege: Coal mining destroys priceless historical sites. European Environmental Bureau; Beyond Coal (n.d.). Sacrificing culture and communities for coal.

[159] Hutchens, Paul (2019). The ethics of energy distribution .

The ethical issues on the *consumption* side are:

1 Extensive energy use:[160] this issue is about how consumers use energy in everyday lives and whether they should strive to reduce energy use.
2 Use of sustainable energy: this is linked to the issue of sustainable production and refers to the complicity of consumers in their energy preferences and whether they should use more renewable energy.

2.6.1. What shocks the AI use in energy sector is likely to produce

As the energy industry is already getting 'smart', AI applications will only accelerate this process and bring it to a new level. Experts are expecting that AI will take over the current 'smart' applications in energy sector and enhance them to becoming 'intelligent'. The McKinsey Global Institute predicts that the potential global economic value of implementing traditional and advanced AI technologies and tools in the oil and gas sector will amount to an economic value of US$402.7 billion or 4.43 % of 2018 sales.[161]

Due to its forecasting capabilities (e.g. forecasting of supply and demand in decentralized system, precise weather forecasts will help forecasting renewable energy generation), AI applications will significantly improve *the functioning, resilience and stability of the power grid* as well as the *management of the power grid*. AI applications can reduce grid congestion at the transmission and distribution levels and facilitate integration of renewable energy sources and micro-producers – without building new power lines. They can also detect or prevent grid disturbance and failures and react to emergencies in real time.[162]

Hopes are high for AI advancing *energy storage* in complex production-consumption decentralised systems (for instance, consisting of large-scale batteries, aggregated small batteries and electric vehicles).[163] This will help overcome the volatility of renewable energy sources (e.g. wind, solar), improve control over them and encourage their wider use accelerating the energy transition.

AI could be a core of the Virtual Power Plant: a coordinated system of all power sources across a large territory that form a 'swarm power plant'.[164] The Virtual Power Plant would have *fully decentralised energy production combining all possible sources of energy* in one giant network or plant.[165] This application will help reduce the pressure in the power grid growing due to new (micro)producers of energy (i.e. prosumers) emerging across Europe.

AI will also *optimise the design and operations on energy market* due to superior algorithmic trading and forecasting that account for the myriad power sources and myriad energy consumers.[166] Big data analytics will help detect anomalies and discover new marketing possibilities due to improved

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160 Dernbach, John and Donald Brown (2009). The ethical responsibility to reduce energy consumption. *Hofstra Law Review* 37, pp. 985-1006 .

161 McKinsey Global Institute (2018): https://www.mckinsey.com/business-functions/mckinsey-analytics/our-insights/the-executives-ai-playbook?page=industries/oil-gas/ .

162 International Renewable Energy Agency (IRENA) (2019). Artificial Intelligence and Big Data: Innovation landscape brief, p 11.

163 Mehta, Bijoy (2019). The Emerging Need for Artificial Intelligence in Energy Storage .

164 Next Kraftwerke (n.d.). What is a Virtual Power Plant?.

165 Bilodeau, Stephane (2019). Artificial intelligence in a 'no choice but to get it smart' energy industry! *Towards Data Science*.

166 International Renewable Energy Agency (IRENA) (2019). Artificial Intelligence and Big Data: Innovation landscape brief.

renewable energy generation forecast and demand forecast. Leveraging of blockchain in combination with AI can offer more individualised solutions in energy consumption (and production) while also protecting personal data and privacy.

Many new AI solutions apply to demand-side management meaning that they can *optimise energy consumption*. By collecting and analysing data on weather conditions, energy prices, occupancy, usage patterns and other factors, AI can reduce energy bill for both industrial users and consumers.[167] The data collected in these circumstances are likely to be sensitive and personalised.

2.6.2. Ethical AI will make a difference by comparison to unfettered AI

In the energy sector, it seems like some ethical issues will be solved by unfettered AI because, while increasing the efficiency of energy distribution, improving the functioning of power grid and rendering markets more efficient, AI will also improve access to energy. The prices are likely to go down due to larger numbers of micro-producers who can join the grid. Understanding of consumption patterns and profiles can help develop energy poverty mitigation measures for individual households. At the same time, the risk of price discrimination grows as more data on consumers are collected and processed. An ethical framework for AI development could ensure more equitable outcomes.

Improvement of energy storage and distribution capacities are also likely to promote sustainable energy, likely allowing for better traceability and information about where the energy comes from (i.e. green or not). On the consumption side, unfettered AI can significantly optimise energy consumption giving consumer precise foresight about their energy profiles and control the energy use, which is likely to lead to more efficient (reduced) energy use.[168] Thus, even unfettered AI would help consumers and industrial users make an ethical choice in favour of sustainable energy use.

Ethical AI would make an important difference in relation to data access and use. For instance, to ensure transparency of prices and market information and to understand decision-making by algorithms, data need to be shared between large energy companies, small prosumers and, ultimately, consumers. The data collected by AI applications is very sensitive as it can reveal detailed information about people's private life. The necessity to constantly monitoring homes through sensors raises concerns about in-home surveillance.[169] An ethical framework will ensure that only the necessary minimum of data is collected, where these data are processed and who can have access to it.

2.7. Financial services

The financial sector encompasses activities and institutions that manage money, such as banks, insurance companies, accountancy, investment funds, hedge funds, stock exchange and others.[170] Ethics of banking and financial sector has been much discussed since the financial crisis of 2008-2009. Some of the important issues are:

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[167] Ibid., p. 13; Bird, Eleanor, Jasmin Fox-Skelly, Nicola Jenner, Ruth Larbey, Emma Weitkamp and Alan Winfield (2020). The ethics of artificial intelligence: Issues and initiatives. STOA Study, p. 11.

[168] Gagan, Olivia (2018). Here's how AI fits into the future of energy. World Economic Forum.

[169] Hatzakis, Tally, Rowena Rodrigues and Wright David (2019). Smart Grids and Ethics. *ORBIT Journal* 2:2.

[170] Asmudson, Irena (n.d.) Financial services: Getting the goods. IMF publications .

1. Conflict of interest (stakeholder versus stockholder):[171] financial advisers are supposed to provide good advice in the best interest of their clients. At the same time, they are usually paid not by a client but by a third party (e.g. their employer, financial product owners) and therefore have incentives to maximise their revenue rather than cater for the interests of the client. Clients lack necessary information to monitor the adviser's behaviour and check his/her advice. Besides, financial information is abundant and complex and requires time and knowledge to properly understand – all of which a client lacks.
2. Stability and risk management:[172] the financial crisis showed multiple flaws in the financial system in this regard, namely excessive and poorly controlled risk taking in investments, self-interest in loans ranking, problems in valuation of loans, lack of diversification in the portfolio, etc. This is due to inability to resolve the conflict of interest and lack of ethical orientation in the industry.
3. Personal data protection:[173] as AI technology will require access to sensitive customer data for the provision of e.g. tailored loan and investment advice. Issues pertinent to data compliance and security from fraud and hacking attacks will be pressing.
4. Bias and discrimination: studies show that certain minorities may be getting fewer loans.[174] Such discrimination needs to be considered when developing and implementing the relevant AI-software, particularly when considering that AI-algorithms have been shown to have racial and gender biases.[175] Another area of discrimination may be found against the elderly, as the use of AI through e.g. customer service chatbots requires a level of technological familiarity that the group in question may lack.

2.7.1. What shocks the AI use in the financial sector is likely to produce

Financial sector is one of the pioneers in experimenting and applying AI to its day-to-day operations. Research shows that most banks already have and implement internal AI strategies (e.g. 75 % of banks with over US$100 billion in assets and 46 % of banks with less than US$100 billion in assets).[176] The McKinsey Global Institute estimates that the potential economic value of further implementing AI technologies in the banking sector will be the greatest of all sectors included in their study: approximately US$1 trillion globally (or 15.4 % of global sales).[177] Traditional AI and analytics are predicted to account for US$660.9 billion, whilst the implementation of advanced AI will equate US$361.5 billion.

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[171] Sifah, David (2009). Ethics: An Essential Prerequisite of the Financial System: Specially Commended. *Finance & Bien Commun*, 33:1, pp. 46-57.

[172] Wehinger, Gert (2013). Banking in a challenging environment: Business models, ethics and approaches towards risks. OECD Journal: Financial Market Trends 2012:2.

[173] He, David, Michael Guo, Jerry Zhou and Venessa Guo (2018). The impact of artificial intelligence on the financial job market. Boston Consulting Group research.

[174] Marks, Gene (2020). Black-owned firms are twice as likely to be rejected for loans. Is this discrimination? *The Guardian*.

[175] Boulamwini, Joy (2019). Artificial Intelligence Has a Problem with Gender and Racial Bias. Here's How to Solve It. *Time*.

[176] Digalaki, Eleni (2019). The impact of artificial intelligence in the banking sector & how AI is being used in 2020. *Business Insider*.

[177] McKinsey Global Institute (2018): https://www.mckinsey.com/business-functions/mckinsey-analytics/our-insights/the-executives-ai-playbook?page=industries/banking/ .

The introduction of AI to *front- and middle-office applications* (e.g. interactions with clients and anti-fraud and risk assessment, respectively) brings the highest cost saving for the financial sector (globally – US$199 billion and US$217, respectively).[178] AI can provide *better regulatory compliance* as it often relies on cognitive fraud analytics, which are modelled to trace customer behaviour, track transactions and identify suspicious activities, assess the information of different compliance systems more efficiently than anti-money laundering (AML) and know-your-customer (KYC) analysts or compliance officers. Banks could *cut* 20 % to 25 % of their *operational costs*, whilst minimising human error, by implementing AI into daily operations.[179]

Banks and insurance companies increasingly rely on AI applications for *customer identification and authentication*, for the deepening of customer relationships (*KYC operations*) and provision of *personalised recommendations through chatbots and virtual (voice) assistants*. Machine learning has the potential to help customers choose loans better than human employees do because the technology can analyse not only customer data but also a great number of financial products and their conditions. For example, financial services providers can analyse wider categories of data (e.g. news, various market developments, weather) against their clients' portfolios to determine how their clients may be influenced by the current events and provide advice or develop new products.[180] At the same time, AI loan decision systems can observe the patterns and behaviours to help banks and insurers determine whether a customer will be good creditor.[181]

Fraud detection and prevention is one of the most popular areas of AI application. It is reported that approximately 26 % of venture capital raised for AI in the sector targets fraud activities and cybersecurity.[182] Successful AI applications could save European financial sector billions of euros annually.[183] Machine learning can detect anomalies in payment flows, assess fraud riskiness by using predictive and prescriptive models and detect fraud in real-time with deep learning techniques.[184]

The growing application of AI will have *significant impacts on jobs* within the sector. As mentioned above, AI is more cost efficient and accurate when it comes to detecting fraudulent activities and unusual patterns, identifying customer needs and choosing suitable financial products. If configured properly, AI will not be caught in a conflict of interest situations. Therefore, AI applications are likely to replace a substantial number (up to 25 %) of AML/KYC compliance officers, traders, market analysts and customer service agents in the financial sector. The affected jobs consist of *standardised and repetitive tasks*. In jobs that involve solving complex financial problems, AI is likely to complement human efforts.[185]

The increased use of AI in the financial sector raises concerns about *'black box' decision-making* and market risks. 'Black box' refers to the complex manner in which AI makes decisions, which makes it more difficult to ensure transparency of the process and to delineate the responsibility. Application

178 Digalaki, Eleni (2019). The impact of artificial intelligence in the banking sector & how AI is being used in 2020. *Business Insider*.

179 Accenture (n.d.). Redefining banking with Artificial Intelligence.

180 Macknight, Joy (2019). An ethical framework for the AI age. *The Banker*.

181 Accenture (n.d.). Redefining banking with Artificial Intelligence.

182 Mejia, Niccolo (2020). AI-Based Fraud Detection in Banking – Current Applications and Trends.

183 The European Central Bank reports annually on card fraud that amounts to almost 2 billion euro. See ECB publishes fifth report on card fraud.
https://www.ecb.europa.eu/paym/intro/mip-online/2018/html/1809_fifth_report_on_card_fraud.en.html.

184 Mejia, Niccolo (2020). AI-Based Fraud Detection in Banking – Current Applications and Trends.

185 He, David (2018). 4 ways AI will impact the financial job market. World Economic Forum.

of AI by a large number of traders may *increase market instability* if they would try to outperform each other using machine learning. Predictable patterns of machine learning strategies become an easy and lucrative target for criminals.[186]

2.7.2. Ethical AI will make difference by comparison to unfettered AI

The use of big data analytics and AI means that financial institutions will amass huge quantities of data and significantly improve their information and knowledge base. The already present information asymmetry between them and their clients will increase dramatically making all clients (not only consumers) more vulnerable to the financial decision-making.[187] The use of ethical framework in this context must assure that the design and deployment of customer-oriented AI applications is consistently performed solely in client's interest. This will resolve the conflict of interest problem once and for all. Unfettered AI, especially when developed by financial institutions, would not guarantee that client's interests are duly considered in all situations. Furthermore, ethical AI applications will ensure that client's behaviour or psychological biases are not exploited (even inadvertently) in a way that is harmful to client's (financial) well-being.[188]

The use of AI-powered systems both for analytic purposes and to assist decision-making can be compromised by (in-built) bias. AI applications are usually trained on historic data that may incorporate biased correlations and injustices, which would then be perpetuated in the system. Ethical framework guiding both the development, training and use of AI and could recommend that datasets are checked before use and specific variables are omitted or corrected for and that there is always a human in the look who checks the input and the output.[189]

As financial institutions start using AI for (support of) decision-making, transparency and explainability become important themes. An ethical framework would provide that firms should institute processes to audit and replicate decision-making by AI in order to be able to understand and document all its steps, models and data.[190] This would ensure that companies are acting in the interest of the client, do not take unreasonable risks and are free of bias.

To minimise risks linked to AI use in the financial sector, an ethical framework can be employed to analyse and determine processes and functions that can be automated as well as the degree, to which they should be automated.[191]

Introducing an ethical framework for AI is likely to hamper the development of AI applications in banking and insurance and lead to European companies lagging behind their overseas competitors with regards to automated decision making, fraud detection, and assessing creditworthiness of borrowers.[192]

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186 Accenture (n.d.). Redefining banking with Artificial Intelligence.

187 Macknight, Joy (2019). An ethical framework for the AI age. *The Banker*.

188 De Nederlandsche Bank (2019). General principles for the use of Artificial Intelligence in the financial sector, p. 37.

189 Macknight, Joy (2019). An ethical framework for the AI age. *The Banker*.

190 De Nederlandsche Bank (2019). General principles for the use of Artificial Intelligence in the financial sector, p. 37.

191 Ibid., pp. 38-39.

192 Brush, Silla (2018). EU's Data Privacy Law Places AI Use in Insurance Under Closer Scrutiny. *Insurance Journal*..

2.8. Health care

The health care sector consists of medical professionals and organisations (e.g. hospitals, clinics) providing medical and remedial care or services. These services include prevention, diagnosis, treatment and recovery / cure of diseases and illnesses, both physical and mental.

Ethical issues in health care are manifold and they may vary for different medical staff (e.g. nurses, doctors). Two major ethical issues are:

1 Patient privacy and confidentiality:[193] confidential relationship between the doctor and the patient is essential for health care. Patient information should be available only to the patient, his/her treating physician and, to the degree required, other medical personnel (e.g. radiologist, nurse).

2 Universal access to equal quality of health care:[194] residents of rural and remote locations may not have access to everything the modern medicine has to offer as they may not have a well-equipped hospital close by. Prices for health care and insurance may be prohibitively high for people on low incomes. Vulnerable groups (e.g. minorities, disabled) may have less choice and lower levels of health care services.

2.8.1. What shocks the AI use in health services sector is likely to produce

The McKinsey research suggests a total potential annual value up to US$906.1 billion globally from implementation of AI in health care.[195] The research for the EU highlights that European investment and research in health-related AI are strong when grouped together, but fragmented at the country or regional level. 'Overall, there is a significant opportunity for EU health systems, but AI's full potential remains to be explored and the impact on the ground remains limited'.[196] It is estimated that annual savings as a result of AI applications in health care may reach US$150 billion to US$269 billion globally.[197]

AI is expected to have tremendous impact on health care. The combination of big data analytics and AI will lead into the era of *personalised medicine*.[198] Instead of a universal approach to treatment for everybody (which is practiced now), personalised medicine will determine the most appropriate approach to treatment of each patient based on the analysis of huge datasets. AI will be able to perform high precision diagnostics and adjust the treatment daily while monitoring patient's condition in real time. It goes without saying that, while the quality of health care and patient

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193 Beltran-Aroca, Cristina M., Eloy Girela-Lopez, Eliseo Collazo-Chao, Manuel Montero-Pérez-Barquero and Maria C. Muñoz-Villanueva (2016). Confidentiality breaches in clinical practice: what happens in hospitals? *BMC Medical Ethics* 17; Sanchini, Virginia and L. Marelli (2020). Data Protection and Ethical Issues in European P5 eHealth. In: Pravettoni G., Triberti S. (eds) P5 eHealth: An Agenda for the Health Technologies of the Future. Springer.

194 Baeten, Rita, Slavina Spasova, Bart Vanhercke and Stéphanie Coster (2018). Inequalities in access to healthcare - A study of national policies. European Social Policy Network (ESPN), Study for the European Commission; Bird, Eleanor, Jasmin Fox-Skelly, Nicola Jenner, Ruth Larbey, Emma Weitkamp and Alan Winfield (2020). The ethics of artificial intelligence: Issues and initiatives. STOA Study, p. 56.

195 McKinsey Global Institute (2018): https://www.mckinsey.com/business-functions/mckinsey-analytics/our-insights/the-executives-ai-playbook?page=industries/healthcare-systems-and-services/ .

196 European Institute of Innovation and Technology (EIT) Health and McKinsey (2020). Transforming healthcare with AI: The impact on the workforce and organisations, p. 12.

197 Forbes Insights (2019). AI And Healthcare: A Giant Opportunity.

198 Schork, Nicholas J. (2019). Artificial Intelligence and Personalized Medicine. *Cancer Treatment and Research* 178, pp. 265-283; O'Neill, Sean (n.d.) Transforming medicine through AI-enabled healthcare. The Alan Turing Institute research.

outcomes are likely to increase tremendously, so will the risks to patient's privacy and data protection.

AI's accuracy and efficiency could boost *quality and cost efficiency of health care*. Initially, this might create inequality in the access to and quality of health care between better equipped, affluent countries and remote or developing areas. However, when implemented on a large scale, differences in welfare and educational standards between countries will vanish and equal high-quality health care will be accessible for all citizens.[199]

Automation could play a significant part in *alleviating workforce shortages* in health care in the EU. Approximately 10 % of nursing activities, like preparing and dispensing medication, internal communication and administration, could be replaced by AI.[200] AI-driven computer programs and robotics can aid and, eventually, also replace doctors in many activities, like diagnosis[201] and clinical decision making.[202] Moderate estimates suggest that, in total, 15 % of current work hours in health case could be automated.[203]

2.8.2. Ethical AI will make difference by comparison to unfettered AI

The use of ethical framework can assure that AI applications, rather than being biased and designed to improve quality matrices, are fair and focus on improving patient care. It would also prevent the development and deployment of AI to increase profits for health care institutions by unnecessarily selling or imposing treatments on patients (e.g. by recommending specific tests, drugs, or devices). Thus, ethical AI can address the tension between generating profits and improving patient care.[204]

An ethical framework for AI might impose restrictions on data accessibility in terms of ownership and viewership, which might prevent training of AI on timely, complete, and representative datasets. This in turn is likely to lead to biased results (i.e. resulting from historical bias) and overall sub-optimal health care quality, as an ethical framework might restrict the possibility for the optimisation of AI applications.[205]

Historical bias of medical datasets is notorious as many trials and tests have been conducted on small samples of populations, often completely excluding women and people of colour.[206] AI applications will reinforce the existing bias preventing under-represented groups and individuals from receiving better health care.[207] Ethics would require a more careful selection of datasets for developing and training AI, provide for possibilities to give feedback and improve the algorithms.

199 Forbes Insights (2019). AI And Healthcare: A Giant Opportunity.

200 European Institute of Innovation and Technology (EIT) Health and McKinsey (2020). Transforming healthcare with AI: The impact on the workforce and organisations, p. 14.

201 Amato, Filippo, Alberto López, Eladia M. Peña-Méndez, Petr Vaňhara, Ales Hampl, and Josef Havel (2013). Artificial neural networks in medical diagnosis. *Journal of Applied Biomedicine* 11:2, pp. 47-58.

202 Bennett, Casey C., and Kris Hauser (2013). Artificial intelligence framework for simulating clinical decision-making: A Markov decision process approach. *Artificial Intelligence in Medicine* 57:1, pp. 9-19.

203 European Institute of Innovation and Technology (EIT) Health and McKinsey (2020). Transforming healthcare with AI: The impact on the workforce and organisations, p. 14. .

204 Ridley, Erik L. (2018). Is artificial intelligence ethical in healthcare?

205 Ridley, Erik L. (2018). Is artificial intelligence ethical in healthcare?

206 See, for example, Criado Perez, Caroline (2019). Invisible Women: Exposing Data Bias in a World Designed for Men, pp. 193-235.

207 Chen, Irene Y., Peter Szolovits and Marzyeh Ghassemi (2019). Can AI Help Reduce Disparities in General Medical and Mental Health Care? *AMA Journal of Ethics* 21:2, pp. 167-179.

Importantly, the role of the human in the loop needs to be defined and the pace with which AI-based decision-making can unfold.

With AI-assisted medicine, a third-party 'actor' is introduced into the relationship between the patient and the physician which challenges the dynamics of responsibility and the expectation of confidentiality in this relationship.[208] This highly sensitive issue can be only addressed by an ethical framework that provides guidance on when and how to use AI when treating a patient.

Inaccurate AI diagnosis or overconfidence in the use of AI systems could have consequences for the quality of care and patient's health and safety. Moreover, these issues raise questions of responsibility, accountability and liability for health outcomes. An ethical framework could ensure that AI applications do not turn into 'black box' and their processes are transparent and can be audited and explained. Specific requirements to training and validating of algorithms can be introduced to ensure that a variety of datasets are used to avoid historical bias leading to adverse health outcomes.[209]

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208 Stanford Medicine (2018). Researchers say use of artificial intelligence in medicine raises ethical questions.

209 Bhatia, Richa (2018). Pitfalls Of AI In Healthcare – The Holy Grail Of Personalised Medicine.

3. European Added Value Assessment of EU policy options

3.1. Measuring European Added Value in ethical artificial intelligence

To better understand and contextualise the array of added value that Europe can provide through releasing the benefits of ethical AI applications in different industry sectors as described in Chapter 2, this report relied on a review of the existing literature, a survey – largely focussed on the potential economic impacts of an ethical framework – and the expertise of the project team. It provides both a qualitative assessment and a quantification of what economic costs and benefits would be to such a framework.

Quantification represented a major methodological challenge for the study, given the lack of data in and dearth of studies that explore these kinds of questions from a quantitative perspective. Measuring the potential quantitative impact of policies in the digital domain is already hugely challenging. Modelling exercises work better in times of stability, where there are plenty of historical data on which to base assumptions. The digital economy, however, has been changing so rapidly that historical data or old assumptions on the effects of certain policies simply cannot be assumed to apply. For example, antitrust law has relied on assumptions around consumer welfare, which measures short-term pricing effects. By these standards, large tech companies like Google and Facebook have had only a positive influence on competition.[210] Yet big tech has had a large impact on competition and markets, effects that are not captured using old assumptions. Using existing standards and measures as assumptions to plug into a theoretical model of how the digital economy works leads not just to inaccurate results, but also causes policymakers to think of future policy decisions in the wrong way – possibly making corrections after it is too late.

Using a structured survey to gather legitimate data

This is the reason why the heart of this study has been a survey, reaching out to digital experts in a cross section of sectors that represent the EU economy, the selection of which is discussed in the introduction to chapter 2 on page 14. Not only were the sectors selected to be representative as both a proportion of the economy as well as on ethical considerations, but the selection of the experts was also representative within each sector, as described in Annex I on page 72. Using a structured process, we gathered a series of suppositions on both the impact of artificial intelligence on various sectors of the economy given the status quo, but also on two policy options (these policy options are described further in section 3.3 on page 48).

While the survey focussed on gathering quantitative data which would be used for the analysis, qualitative justifications for the experts' suppositions were requested. In some cases, it showed the level of disagreement on the perceived impacts, and in particular for the level of involvement of Europe that would be desired. While various iterations of the survey helped to bring a consensus to the results, the variety of responses also factor into the analysis of the level of impact, both qualitatively and quantitatively.

Using a CGE model to quantify the impacts based on the survey data

Based on the information gathered from experts across various spectra, the impacts of artificial intelligence were quantified using a computable general equilibrium model (CGE). Given the disruptive nature of artificial intelligence and robotics, CGE is better suited than purely econometric

210 Khan, Lina M. (2017). Amazon's Antitrust Paradox. *Yale Law Journal*, pp. 564-907.

techniques that rely on extracting patterns from the past. Techniques that rely on pattern building are further limited by the need to rely on specialized datasets, which may be either unavailable or difficult to access. In contrast, a structural modelling approach details the motivation and incentives of economic agents, thus increasing robustness in the face of structural changes. Specifically, CGE models are suitable for this type of analysis because they are based on explicit microeconomic foundations, which helps trace the channels of impact and provides a degree of robustness against over-reliance on pattern extraction and extrapolation from the past. At the same time, sectoral interlinkages allow the measurement of indirect effects arising from changes in a specific sector.

The CGE methodology comes with its own set of limitations. It relies on the availability of specially structured data for a particular period that is assumed to represent a (near) equilibrium state of the economy. This creates a potential trade-off between recency, availability and representativeness. Moreover, the economic structure embedded in CGE models may hinder the extensive modelling of specialized topics (environmental issues, energy, climate change) that can be incorporated in traditional econometric models.

The theoretical structure of the model follows the one described in EC(2016),[211] an open economy model with a tailor-made sectoral breakdown. It was further enhanced with dynamic equations that compute the impact of a set of shocks per sector over a specified time horizon. It is assumed that the economy is divided in sectors, each producing a specific product.[212]

The model was calibrated using recent data for the EU economy.[213] The results from the survey provided additional input for the calibration of the model. The effects computed from the Delphi questionnaire are partial effects for the respective sector and were applied to calibrate the size of the shocks through the relevant equations in the model (see Annex II for more details).

Relying on the literature and expert team to understand the qualitative impacts

While the survey and economic model are core methodological elements of this study, understanding and interpreting some of the results required further context, gathered both from the literature study – some of which has already been outlined in chapter 2 – as well as the combined expertise of the research team.

These data sources provide the starting point of the analysis that follows. The first part of the analysis outlines, qualitatively, the added value of Europe providing a framework for ethical artificial intelligence and robotics (section 3.2). This added value was collected irrespective of what policy option that Europe might put forward, as they are applicable to any (legitimate) framework that might be created. Following this discussion of added value, the analysis describes the policy options that were examined as a part of this study (section 3.3). From here, the report presents the expected quantitative impacts of an ethical framework on the EU economy given the policy options (section 3.4). It then contextualises the qualitative elements of the EU added value outlined in section 3.2 by analysing which policy option would have the greatest impact (section 3.5).

211 WIK-Consult, Ecorys and VVA Consulting (2016). Support for the preparation of the impact assessment accompanying the review of the regulatory framework for e-communications. Study for the European Commission.

212 Sometimes sectors are referred to as 'activities', while products are referred to as 'commodities', following established terminology in the CGE literature.

213 Most of the model coefficients are calibrated using public data from Eurostat, with a limited number of coefficients calibrated on theoretical grounds with values taken from the relevant literature. The bulk of the calibration is implemented by constructing a social accounting matrix (SAM) that measures the flows between the different institutional sectors of the economy for a selected base year. Additional data-based calibrations outside the SAM framework were carried out again using Eurostat data.

3.2. European Added Value in the Ethical Use of Artificial Intelligence

An ethical framework for artificial intelligence provides potential macro-economic benefits for artificial intelligence applications in different sectors of the economy (those applications are described in detail in Chapter 2). This section outlines the origins of those potential benefits, specifically describing the added value of an EU-wide ethical framework over purely national efforts.

3.2.1. Increase the social acceptance of the technology

The Technology Acceptance Model, developed in 1989 by Fred Davis, has been much mentioned in the literature to predict how easily new technologies will be accepted by users and consumers.[214] While the foundation of this model lies on two factors – the perceived usefulness of a new technology and subjective belief that a technology will improve productivity or enjoyment – the element of trust and perceived risk were elements added to the model in the 2000s by Paul Pavlou.[215] This paper was written in the context of e-commerce, to which consumers initially showed mistrust given concerns over fraud, but remains equally applicable to the conversation around artificial intelligence.

While application of this model on artificial intelligence is relatively scarce, it remains clear that social acceptance of technology is critical for its widespread adoption. Jim Al-Khalili, president of the British Science Association in 2018, warned that artificial intelligence and its applications could face a European backlash similar to the one faced by genetically modified crops, a technology that continues to face distrust (though a distrust that is declining over time).[216] Social acceptance of any new product or technology depends on trust, and if artificial intelligence gains a reputation as being inaccurate or dangerous, people will be less willing to use it and regulators will potentially create strong regulatory barriers in the future.

The risk factor for artificial intelligence is particularly relevant given that one of the originating notions of the technology was that these systems were assumed to be neutral and objective in areas such as criminal justice.[217] In 2018, the American Institute of Justice promoted the use of artificial intelligence as a way to overcome some of the limitations of human operators. When discussing the use of video surveillance, the report notes that 'Video and image analysis is also prone to human error due to the sheer volume of information'.[218] Yet, particularly over the past couple of years, numerous stories have reached the popular media discussing surveillance and biases in areas such

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214 Davis, Fred D (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly* 13:3, pp. 319–340.

215 Pavlou, Paul (2003). Consumer Acceptance of Electronic Commerce: Integrating Trust and Risk with the Technology Acceptance Model. *International Journal of Electronic Commerce* 7, pp. 101–134.

216 Financial Times (2020). Artificial intelligence faces public backlash, warns scientist.

217 Araujo, Theo, Natali Helberger, Sanne Kruikemeier, and Claes H. de Vreese (2020). In AI We Trust? Perceptions about Automated Decision-Making by Artificial Intelligence. *AI & SOCIETY*.

218 Rigano, Christopher (2019). Using Artificial Intelligence to Address Criminal Justice Needs. *NIJ Journal* 280.

as facial recognition,[219] decisions over bail,[220] sentencing,[221] recruiting,[222] control over mandatory wearing of face masks[223] and other areas. These stories emphasise the risks of imperfect systems, and researchers have identified so-called 'algorithm aversion', where people lose confidence in algorithmic decision-making much more quickly than human decision-making when errors appear – even in cases where the algorithm would produce better results overall than a human.[224]

The research identified other ethical issues that constitute barriers to social acceptance of AI. Among the most important are the inability to explain the processing steps and decision-making by AI and the common misconception of AI as general intelligence (instead of narrow intelligence) that will outperform and dominate humans. These factors are exacerbated by the widespread neglect and failure to integrate ethical concerns in the AI development – accompanied by the development of AI for malevolent purposes (e.g. weapons, surveillance).[225]

In the survey conducted for this study, described more fully in section 3.3, to quantify the impacts of an ethical framework on the European economy, those who believed that a framework would provide an overall positive economic impact specifically referred to the social acceptance of technology as the most important driver. Negative headlines about artificial intelligence creating discriminatory or incomprehensible results will only serve to sow distrust about the technology, risking a backlash from both the public as well as policymakers who may react much more negatively should a framework not be in place that can help to create trust that AI applications will be held to the same (ethical) standard as human decision makers, and that safeguards remain in place to ensure that any biases or ethically undesirable results will be quickly rectified.

3.2.2. Further emphasise a niche for European competitiveness in a global marketplace

In November 2019, the Wall Street Journal reported on a partnership between Google and Ascension, a US health provider with 150 000 associates and 40 000 health providers, who had signed an agreement to share patient data without the explicit consent of Ascension patients.[226] Google has been reportedly using this data as a part of their development work in artificial intelligence and machine learning in the health sector, to develop tools that will help with, in the words of Google, 'clinical quality and patient safety'.[227] The sheer number of records to which Google

219 Harwell, Drew (2019). Federal study confirms racial bias of many facial-recognition systems, casts doubt on their expanding use. *The Washington Post*; deVolkskrant (2020). Sleutelen aan gezichtsherkenning levert meer op dan ermee stoppen.

220 Simonite, Tim (2019). Algorithms Should've Made Courts More Fair. What Went Wrong? *Wired*.

221 Metz, Cade and Adam Satariano (2020). An algorithm that grants freedom, or takes it away. *The New York Times*.

222 For example, Fiedler, Tristan (2020). Warum Künstliche Intelligenz schon bald über den Erfolg eurer Bewerbung entscheiden könnte – und was ihr dazu wissen solltet. *Business Insider* and Die Zeit (2020). Ersetzt Künstliche Intelligenz bald den Jobvermittler? .

223 Hamon-Beugin, Valentin (2020). Comment la technologie française peut contrôler le port du masque obligatoire. *Le Figaro*.

224 Dietvorst, Berkeley J, Joseph Simmons, and Cade Massey (2015). Algorithm Aversion: People Erroneously Avoid Algorithms after Seeing Them Err. *Journal of Experimental Psychology: General*, pp. 114–126.

225 Delponte, Laura (2018). European Artificial Intelligence (AI) leadership, the path for an integrated vision. Study for the ITRE Committee of the European Parliament, p. 18.

226 Copeland, Rob (2019). Google's 'Project Nightingale' Gathers Personal Health Data on Millions of Americans. *Wall Street Journal*.

227 Google Cloud Blog. Our Partnership with Ascension.

could gain access would provide it with a large data advantage in the training of their algorithms and AI technologies.

At the same time, in July 2017, China's State Council released the countries strategy on artificial intelligence, with a stated ambition of becoming the leading player in the field by 2030. While the strategy specifically mentions a respect for human rights, privacy, and fairness as important principles, researchers have pointed out that China has traditionally had weak data protection standards, and those that exist are centred around protections for groups rather than for individuals.[228] Data collection within this context also means that individual consent is rarely, if ever, gathered from individuals in order to access large amounts of data in order to conduct development work.

Several reports have addressed the fact that Europe tends to lag both the United States and China in terms of digitisation and artificial intelligence. A 2019 McKinsey report points out that Europe is not home to any of the top 10 internet companies and that the continent lagged badly behind in terms of investment per capital.[229] The perceived lack of data protection and privacy standards in both China and the US has only fed the impression that the gap between Europe and other leading players could continue to widen. Some argue, in fact, that the General Data Protection Regulation has imposed compliance costs and the need to get individual consent creates burdens for developers that do not exist in jurisdictions like the US and China.[230]

Other research[231] suggests that Europe as a whole is not so far behind in developing AI technologies. The EU ranks second in the number of AI startups, and some large cities (Berlin, Paris) have a 'vibrant and mature AI landscape'. The EU has more AI researchers than the US and China, produces more research[232] and is particularly strong in core AI systems (i.e. fundamental AI research). This research found that the fact that the Digital Single Market remains incomplete is the main weakness of the EU.

Some policymakers and thinkers in the field argue that Europe's moves into trustworthy AI, which includes creating a legislative framework that addresses the emerging ethical field of data protection and privacy, can become a competitive benefit.[233] On one level, it provides a framework to develop niche markets for European companies. ETHYKA, a Spanish SME developing AI-enabled chatbots, produces tools that help to maintain ethical behaviour of AI tools from other companies.[234]

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228 Roberts, Huw, Josh Cowls, Jessica Morley, Mariarosaria Taddeo, Vincent Wang, and Luciano Floridi (2019). The Chinese Approach to Artificial Intelligence: An Analysis of Policy and Regulation. SSRN Scholarly Paper. Rochester, NY: Social Science Research Network.

229 McKinsey Global Institute (2019). Notes from the AI Frontier: Tackling Europe's Gap in Digital and AI.

230 Castro, Daniel, McLaughlin, Michael and Chivot, Eline (2019). Who Is Winning the AI Race: China, the EU or the United States? Research paper by Center for Data Innovation. At the same time, legal research into the GDPR found that it can be 'interpreted and applied in such a way that it does not substantially hinder the application of AI to personal data, and that it does not place EU companies at a disadvantage by comparison with non-European competitors', see Sartor, Giovanni and Francesca Lagioia (2020). The impact of the General Data Protection Regulation (GDPR) on artificial intelligence. STOA Study.

231 See findings by Delponte, Laura (2018). European Artificial Intelligence (AI) leadership, the path for an integrated vision. Study for the ITRE Committee of the European Parliament, pp. 15-17.

232 See evidence collected by Castro, Daniel, McLaughlin, Michael and Chivot, Eline (2019). Who Is Winning the AI Race: China, the EU or the United States? Research paper by Center for Data Innovation.

233 Rugova, Erik Brattberg, Raluca Csernatoni, Venesa, and Erik Brattberg Rugova Raluca Csernatoni, Venesa (2020). Europe and AI: Leading, Lagging Behind, or Carving Its Own Way? Carnegie Endowment for International Peace; van Wynsberghe, Aimee (2020). Artificial intelligence: From ethics to policy. STOA Study, p. 32.

234 See https://www.ethyka.co/index_eng.html .

More importantly, it (potentially) obliges non-European companies to follow European ethical standards, at least when developing and implementing tools for the European market and/or that require access to large amounts of European data.[235]

3.2.3. Facilitate access to pan-European datasets across the European Union for developers of AI applications

While it is overly simplistic to suggest that bigger datasets always provide benefits to developers of artificial intelligence applications – those datasets need to be formatted correctly and provide the right kinds of data for the application being developed[236] – the more data that developers have access to so that they can make a smart selection, the better.[237] And emerging ethical standards around data protection and privacy mean that a pan-European approach to ethical standards is vital to ensuring access to European datasets. A hodgepodge of Member State standards would mean that developers would likely have increased barriers to unified datasets caused by internal digital borders.[238] On the other hand, this may lead to 'ethics shopping' with companies moving to EU Member States with lower ethical standards.

It is worth noting that ethical standards are not the only barrier to a single market for European datasets. For example, the European Commission continues to work on creating standards to open pubic-sector datasets for private use,[239] as encapsulated in the Open Data Directive.[240] Barriers to the interoperability of datasets from various data providers across Europe are legal, organisational, semantic and technical in nature. Ethical considerations around data sharing and usage in AI applications represents a potential additional barrier, which coordinated European action would circumvent.

3.2.4. Provide legal certainty for European AI developers and users

Linked to the above considerations on fostering AI development, a patchwork of ethical requirements is likely to further discourage companies from developing AI for the European market and from using it. Just as legal certainty is found to be crucial in the questions of liability for AI applications,[241] companies need certainty of ethical framework that guides the usage of tools available for innovation (e.g. datasets for training), testing and deployment of their new products and services, nationally or cross-border. Without an EU-wide guidance, the single market may fragment with regard to ethical requirements, and public authorities may be unclear on whether

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235 It should be admitted that this does not resolve potential imbalances for developing AI technologies, but only limits companies that want to train their algorithms and AI tools using European data. At the moment, the policy options considered for this report do not consider barring the roll out of technologies that have been developed using unethical standards in other jurisdictions.

236 For a discussion on file formats required to train AI application, see Dowling, Jim (2019). Guide to File Formats for Machine Learning: Columnar, Training, Inferencing, and the Feature Store. Towards Data Science.

237 See for a discussion of when too much data can be a problem, Lipeles, Aaron (2019). AI/ML Practicalities: More Data Isn't Always Better. Medium.

238 Delponte, Laura (2018). European Artificial Intelligence (AI) leadership, the path for an integrated vision. Study for the ITRE Committee of the European Parliament, pp. 19-20.

239 European Commission - Data Policy and Innovation (Unit G.1) (2020. European Legislation on Open Data and the Re-Use of Public Sector Information. Shaping Europe's digital future. https://ec.europa.eu/digital-single-market/en/european-legislation-reuse-public-sector-information.

240 Directive (EU) 2019/1024 of the European Parliament and of the Council of 20 June 2019 on open data and the re-use of public sector information, OJ L 172 of 26.06.2019.

241 Delponte, Laura (2018). European Artificial Intelligence (AI) leadership, the path for an integrated vision. Study for the ITRE Committee of the European Parliament, p. 20.

and when to intervene to ensure safety and security of products and services. Companies, especially SMEs and startups that lack resources for legal research and advice, may decide to leave the market and innovate elsewhere or not to take up new products if they encounter unclear in their diversity regulatory situation. Against this backdrop, an ethical framework would not only foster the development and uptake of AI technology, but also provide legal certainty for investors in the relevant R&D&I.[242]

AI practical use is still in an immature state. With the intensified commercial deployment of AI applications, more and probably unexpected ethical and moral issues of AI usage will emerge. The lack of ethical guidance on how to deal with these issues is likely to provoke uncertainties among developers and users, leading to a decline in trust and acceptance of the technology.[243]

3.2.5. Project European values across the Member States and internationally

Earlier in this section, the idea of the Brussels Effect was briefly addressed, and the idea that Europe has become a world leader in rule-making around areas such as data protection and consumer protection has become more prevalent.[244] The European Union is presenting an alternative to American, Chinese, or Russian development paths, and it is a path that gains increasing attention and influence. In a 2019 address to the United Nations, Secretary-General António Guterres urged countries to follow the example set by the European Union General Data Protection Regulation.[245] Following the passing of the General Data Protection Regulation, its principles have appears in numerous jurisdictions, some of which are listed in the table below.[246]

Table 4: Countries that (partially) adopted the EU approach to data protection

Country	Legislation	Date in effect
Australia	Privacy Amendment (Notifiable Data Breaches) to Privacy Act	February 2018
Bahrain	Personal Data Protection Law	August 2019
Brazil	General Data Protection Law	August 2020
Thailand	Personal Data Protection Act (PDPA)	May 2020
US	California Consumer Privacy Act	January 2020

While the increasing relevance of Europe as a global rule-maker can be seen from a soft power and diplomatic perspective, there remains a value in protecting and projecting European values in and

[242] Craglia M. (Ed.), Annoni A., Benczur P., Bertoldi P., Delipetrev P., De Prato G., Feijoo C., Fernandez Macias E., Gomez E., Iglesias M., Junklewitz H, López Cobo M., Martens B., Nascimento S., Nativi S., Polvora A., Sanchez I., Tolan S., Tuomi I., Vesnic Alujevic L. (2018). Artificial Intelligence - A European Perspective, EUR 29425 EN, Publications Office, Luxembourg, JRC113826, pp. 60-61; Martens, Bob and Jorren Garrez (2019). Cost of non-Europe in robotics and artificial intelligence: Liability, insurance and risk management. EPRS study, p. 45.

[243] Delponte, Laura (2018). European Artificial Intelligence (AI) leadership, the path for an integrated vision. Study for the ITRE Committee of the European Parliament, p. 32.

[244] Teneo (2020). Europe in the World: From Soft Power to Rule-Maker.

[245] UN Secretary-General (2019). Secretary-General, Addressing Italian Senate, Warns of 'Great Fracture' amid Rising Great-Power Rivalry, Asymmetric Conflicts, Climate Crisis.

[246] Information is compiled from a combination of Simmons, Dan (2020). 6 Countries with GDPR-like Data Privacy Laws and Lexology (n.d.). The Impact of the GDPR Outside the EU. It should be noted that some jurisdictions, such as South Korea (and the aforementioned example in Canada) have had data protection laws before GDPR was implemented.

of itself, irrespective of whether it helps to meet particular policy goals. The European Union is providing an alternative example to other key powers such as the US, Russia or China.

3.3. Policy options for the EU framework on ethical aspects of AI

3.3.1. Necessity of a joint EU-level action

Today's digital economy, which increasingly relies on platforms, gives an advantage to scale and network effects. Organisations that control the main platforms, on which users and businesses interact, provide both direct financial benefits as well as indirect benefits of access to flows of data.[247] These data flows are particularly relevant in the race for supremacy in the field of artificial intelligence, where large datasets are used to train and improve applications. Many of the leading companies in the field of artificial intelligence, such as Amazon, Google, Microsoft, and Alibaba, all have ready access to datasets from their other global business activities. Europe, at the moment, lacks data leaders.[248]

The path that Europe has created to become a leader in digital (and artificial intelligence), however, has diverged from other jurisdictions, such as the US or China. The General Data Protection Regulation and the upcoming ePrivacy Regulation are examples of a European approach based on European values. These are values that influence global views, which Anu Bradford has eloquently described as the Brussels Effect.[249] Europe is reshaping the way that the digital market in general and artificial intelligence in particular can continue to develop in the future. Europe looks to set the standard by which others will have to follow.

But to become a world leader of emerging ethical standards around artificial intelligence, Member States need to act in unison so that Europe has the power to project its values and standards on a world stage.[250] Individual Member States quite simply do not have the size and scale necessary to project itself on a globalised digital economy. European added value in this space comes out of this necessity, as the benefits of an ethical framework can only be achieved when Europe projects a single standard.

The Canadian experience in the province of British Columbia, which had passed the Freedom of Information and Protection of Privacy Act (FIPPA) in 2004, provides an example of why only a unified European approach creates the necessary leverage. This legislation, designed to protect personal data held by the public sector in the province, introduced challenges to public-sector organisations looking to leverage private-sector ICT solutions. In the education sector, for example, companies would develop solutions that would be of potential interest to delivery of services, but when confronted with the compliance expectations of the legislation, companies would claim the costs were too high. Many innovative solutions could not be implemented in the province because the province was a generally small market within the larger North American context. With the passing of the GDPR, however, global companies have changed their development paths to comply with European standards, which fall in line with the British Columbian legislation standards. Innovation

247 Lerner, Andres V. (2014). The Role of 'Big Data' in Online Platform Competition. *Telecommunications & Regulated Industries eJournal*.

248 Kahn, Jeremy (2018). Why Can't Europe Do Tech? *Bloomberg*.

249 The Brussels Effect: How the European Union Rules the World. Oxford, New York: Oxford University Press, 2020.

250 Some scholar argue that the EU already provides a 'unifying framework for AI development', while many Member States adopted national AI strategies, see Bird, Eleanor, Jasmin Fox-Skelly, Nicola Jenner, Ruth Larbey, Emma Weitkamp and Alan Winfield (2020). The ethics of artificial intelligence: Issues and initiatives. STOA Study, pp. 73-75.

paths for these companies have changed, opening opportunities for smaller jurisdictions outside of Europe to follow higher data privacy standards.[251]

3.3.2. Policy options for EU-level actions

The research paper has developed three main policy options on the basis of ongoing academic and policy debates on the regulation of ethical development and use of AI, robotics and related technologies. The baseline assumes that the European Commission maintains its current agenda. It is worth noting here that this includes an existing legislative base that protects existing ethical considerations and some emerging ones, such as through the GDPR. The baseline is *not* an 'unethical' framework without European values.

The two other policy options assume that the European Union will engage an ethical framework along the lines described by High-Level Expert Group on Artificial Intelligence, as described in Chapter 1 (and defined in the survey for the experts). The key difference in the two policy options is that the first assumes legislation that provides a uniform or common approach across Europe. All Europeans would be held to the same standard and receive the same level of protection. The policy option 2 assumes that the European Union would adopt a Directive that would provide a minimum standard of ethical protections, but would allow Member States to provide for additional protections: ethical protections exist across the European Union, but some Member States may enact more stringent standards. This approach is the more cautious of the two.

Experts were also provided with a description for what an ethical framework means. Importantly, this ethical framework was not described in operational detail. Because the study is looking to capture macroeconomic effects on the entire economy, it could not capture unique requirements of particular sectors.

The way that each of these policy options were described is shown below.

Scenario 0: Baseline

Scenario 0 (baseline) is a 'no policy change' or 'business as usual'. This means that all relevant EU-level and national policies and measures that are in force or in planning continue in their current state. This includes general legislation, for example, on consumer protection, gender equality, free flow of data, data protection and privacy as well as sectoral legislation (e.g. healthcare, agriculture).

Policy option 1: Common approach

An EU-level regulation is introduced requesting to ensure that the development, deployment and use of AI, robotics and related technologies complies with the ethical framework as developed by the HLEG-AI. This means that AI applications must respect human autonomy, prevent harm, and ensure fairness.[252] Developers and providers should:

1. Acknowledge and address the potential tensions between these three principles;

[251] Whiffin, Stephen. Director of Instruction and Chief Information Officer, School District 43 (Coquitlam, Metro Vancouver), Interview by David Regeczi in Port Moody, Canada. Date Interviewed, July 28, 2020.

[252] Developers and providers should: (1) Acknowledge and address the potential tensions between these three principles; (2) Pay particular attention to vulnerable groups, such as children, persons with disabilities, or others that have historically been excluded or discriminated against; (3) Also pay attention to power or information imbalances, such as between employers and workers, or between businesses and consumers; (4) Acknowledge that, while bringing substantial benefits to individuals and society, AI systems also pose risks, including difficult-to-anticipate impacts (e.g. on democracy, the rule of law and distributive justice, or on the human mind itself.

2. Pay particular attention to vulnerable groups, such as children, persons with disabilities, or others that have historically been excluded or discriminated against;
3. Also pay attention to power or information imbalances, such as between employers and workers, or between businesses and consumers;
4. Acknowledge that, while bringing substantial benefits to individuals and society, AI systems also pose risks, including difficult-to-anticipate impacts (e.g. on democracy, the rule of law and distributive justice, or on the human mind itself.

As such, Europe may look to create a framework that would mitigate these risks. These principles can be made operational through a number of methods outlined by the HLEG-AI, including (but not exclusive to):

- 'Human oversight' through governance mechanisms, such as a human-in-the-loop (HITL), human-on-the-loop (HOTL), or human-in-command (HIC) principles;
- Audits of AI system, both at development and deployment phases; and
- Privacy and data protection via cybersecurity certification, which should take place throughout a system's entire lifecycle.

Policy option 2: Coordinated approach

At the EU level, a framework (directive) of ethical principles is introduced for the development, deployment and use of AI, robotics and related technologies as described in policy option 1 'Common approach'.

However, Member States will need to implement these principles through their legislation and can go over and above the minimum requirements. No new governance structures are created at the EU level. Member States are free to adjust their national governance structures as they deem fit.

The developed policy options present different approaches with regard to the ambition and intensity of the EU intervention steering the technological and economic development. In terms of the compliance with the principle of subsidiarity (i.e. whether the objective of the proposed action can be better achieved at the EU level, rather than by Member States alone), this whole study deals with it by determining the European added value and quantifying it (see Sections 3.5 and 3.6 for results). In terms of the proportionality principle, the policy options were developed to show the possible spectrum of potential interventions to achieve various objectives (e.g. smooth functioning of internal market, consumer protection or promoting R&D&I). Thus, policy option 1 is the most interventionist in the sense that a common (uniform) approach would most strongly restrict the ability of Member States to legislate on an ethical framework for AI. By contrast, policy option 2 is least interventionist as the EU would be solely coordinating national efforts to ensure consistency of approaches to ethical framework across Member States.

A number of assumptions were made regarding the sizes of the shocks on the economy that each policy option means for the economy. Facing the absence of the necessary data and estimates of the impacts of ethical AI in the literature, we applied the Delphi method.[253] Specifically, we used it to compile a list of quantitative shocks that could be attributed to each policy option and status quo per sector. The method consisted of three iterations, where questions were asked regarding the impact on job openings, number of people willing to work, demand for products, productivity, innovation, investment and transparency in a certain sector. The answers to the questions where

[253] The Delphi method was developed and successfully deployed to forecast and assess complex issues when data are not available. This was chosen as an alternative to a workshop, thereby tapping into 'collective intelligence' of geographically separated experts. Each expert's opinion remained anonymous to each other, therefore any potential bias or domination in assessment was prevented.

consensus[254] was reached, were used to calculate the size of the impact. The details on the process, the number of experts and the questionnaire design are presented in Annex I.

Table 5 and Table 6 below list the sizes of the shocks per sector. It specifies the impacts on the number of job openings (or demand for labour), number of people qualified and willing to work in the whole sector (or supply of labour), demand for products, productivity, innovation, investments and transparency in five years.

Table 5: Cumulative impact per policy option per sector, in percentages

Sector	Job openings	Number of people willing to work	Demand	Productivity	Innovation	Investment	Transparency
Status quo or baseline, impact in five years							
Agriculture	0.00	2.50	4.00	5.25	6.75	5.25	0.25
Construction	-2.70	3.60	0.60	5.70	4.20	2.40	1.80
Finance	1.75	2.25	2.75	4.50	5.25	4.50	1.25
Healthcare	2.10	-0.60	3.90	1.80	4.80	4.20	2.40
Telecom and e-communications	2.50	2.00	7.50	4.50	4.50	2.00	1.00
Automotive	-3.50	-0.30	-1.20	3.25	4.00	3.00	0.00
Energy	0.00	1.50	2.25	3.00	2.25	3.38	0.00
Transport	0.86	0.00	4.50	1.29	3.43	4.07	-0.64

Note: job openings refer to the number of job openings; the number of people willing to work refers to the number of people who are qualified and willing to work in all professions in the sector; demand refers to the demand for all products and services; productivity refers to the possibility to produce more products or services with less input or resources needed.

For the two policy options, the size of the shocks is reported relative to an alternative path (the baseline in the case of policy option 1, and policy option 1 in the case of policy option 2). Thus, the Delphi responses for policy option 2 were first rebased to be relative to the baseline instead of to policy option 1. Second, the shocks were calibrated to produce the corresponding deviations from the baseline in 2025 using the rebased Delphi effects. For each shock, it was again assumed that the maximal size of the impact is reached in 2025 and then kept constant until the end of the simulation horizon. For the periods up to 2025 the size of the shocks was computed by linear interpolation.

[254] Consensus was determined in advance and considered to be reached when at least 65% of experts in certain sector agreed on the direction of the impact, see Annex I for further details on the Delphi method.

Table 6: Impact per policy option per sector, in percentages

Sector	Job openings	Number of people willing to work	Demand	Productivity	Innovation	Investment	Transparency
Policy option 1: Common approach, impact compared to status quo (in five years)							
Agriculture	1.00	2.00	4.00	0.29	0.42	3.25	3.25
Construction	-1.20	3.00	0.60	0.56	0.56	0.60	3.00
Finance	0.60	0.60	3.30	0.20	0.20	3.30	3.30
Healthcare	0.00	2.25	3.00	0.40	0.58	2.63	3.38
Telecom and e-communications	4.50	2.00	4.50	0.40	0.40	3.00	6.00
Automotive	-0.30	0.60	1.20	0.25	0.44	3.00	2.70
Energy	2.25	2.25	4.13	0.33	0.40	2.25	5.25
Transport	0.21	1.29	4.71	0.28	0.43	4.93	4.29
Policy option 2: Coordinated approach, impact **compared to policy option 1** in five years							
Agriculture	0.50	1.00	3.25	0.23	0.23	0.75	2.25
Construction	-1.20	1.20	0.60	0.11	0.15	0.60	2.70
Finance	-0.75	-2.63	2.25	0.20	0.25	0.00	0.75
Healthcare	-0.75	0.75	0.75	0.15	0.23	-1.88	-0.75
Telecom and e-communications	3.00	2.00	3.50	0.00	0.00	3.00	2.00
Automotive	-1.20	-0.60	0.00	0.08	0.15	0.75	-0.50
Energy	3.00	4.13	3.38	0.15	0.15	3.38	1.50
Transport	1.20	1.50	3.00	0.12	0.15	3.50	2.25

Note: job openings refer to the number of job openings; the number of people willing to work refers to the number of people who are qualified and willing to work in all professions in the sector; demand refers to demand for all products and services; productivity refers to the possibility to produce more products or services with less input or resources needed.

In addition to the calculated impacts, information was collected about environment degradation, sectoral integration and emergence of the new sector. Given the set-up of the CGE model, these characteristics could not be incorporated into the model.

3.4. What are the quantitative impacts of various policy options?

The estimated impacts in terms of GDP, consumption, employment and capital stock are shown in Table 7. The results are presented as percentage deviations from the baseline (i.e. the status quo) for the years 2020 to 2030. For employment and real GDP, the estimated impact is also calculated in absolute terms, presented in Table 8. The impacts in absolute values were calculated using the baseline values in absolute terms as constructed from the Spring 2020 Economic Forecast. The baseline values of GDP, value added and employment were constructed on the basis of the

Spring 2020 Economic Forecast of the European Commission. The exact methodology applied is presented in Annex II.

For all four variables the deviations from baseline are positive, indicating relative increases in case the respective policy option is implemented. The dynamics of the deviations reflect the expectation that, if the respective policy package is implemented in the first year of the simulation, it will take several years for the EU economy to fully adjust and the effects will be completely manifested by 2025. From 2025 onwards the differences from the baseline path stabilize or increase marginally only as a result of the endogenous model dynamics.

The size of the impact is the largest for private consumption, indicating potential for improvements in welfare if either policy option is implemented. Employment is also expected to experience sizable effects, with the deviation from baseline stabilizing at 1.6 % under policy option 1 and 2.2 % under policy option 2. In absolute values, this means that the employment will be higher than the baseline by 3.188 million people (or 4.343 million people) under policy option 1 (or Scenario 2) in 2025. In 2030, this difference will increase to 3.303 million people under policy option 1 or 4.559 million people under policy option 2.

Real economic activity, measured through the changes in real GDP, is expected to increase by 1 % in 2024 or by €146 917 million under policy option 1 compared to status quo. The deviation from the baseline values continues to rise and reaches 1.4 % or €221 754 million over the baseline under policy option 1. The differences of real GDP compared to baseline are slightly higher under policy option 2: records a deviation of just below 2 % or €294 839 million in 2030.

The paths followed by the capital stock deviations under both policy options are smoother due to continued accumulation of investment over the entire simulation period. Negligible deviations for the baseline capital stock values are recorded in the first two years.[255] In 2030, the capital stock is expected to deviate from baseline by 0.7 % or 0.9 % under policy option 1 and 2 respectively.

Table 7: Impact of implementing policy options 1 and 2 on selected macroeconomic variables (percentage deviations from baseline scenario values)

	Real GDP		Private consumption		Employment		Capital stock	
	PO 1	PO 2	PO 1	PO 2	PO 1	PO 2	PO 1	PO 2
2020	0.2	0.3	0.2	0.3	0.3	0.3	0.0	0.0
2021	0.4	0.5	0.5	0.7	0.5	0.7	0.0	0.0
2022	0.6	0.8	0.7	1.1	0.8	1.0	0.1	0.1
2023	0.8	1.1	1.0	1.5	1.0	1.4	0.1	0.1
2024	1.0	1.4	1.2	1.9	1.3	1.8	0.2	0.2
2025	1.3	1.7	1.5	2.3	1.6	2.1	0.3	0.3
2026	1.3	1.7	1.6	2.4	1.6	2.2	0.4	0.5
2027	1.3	1.8	1.7	2.4	1.6	2.2	0.5	0.6
2028	1.4	1.8	1.7	2.5	1.6	2.2	0.6	0.7

255 As the model uses beginning-of-period capital stocks, the impact in 2020 is by definition zero and the impact in 2021 is positive but below the precision reported In the table.

2029	1.4	1.9	1.8	2.6	1.6	2.2	0.7	0.8
2030	1.4	1.9	1.8	2.6	1.6	2.2	0.7	0.9

Note: PO stands for Policy option.

Table 8 Impact of implementing policy options 1 and 2 on selected macroeconomic variables (absolute deviations from baseline scenario values)

	GDP		Employment	
	Policy option 1	Policy option 2	Policy option 1	Policy option 2
2020	24 400	32 575	488	646
2021	53 014	71 147	1 012	1 358
2022	82 400	110 658	1 535	2 072
2023	113 695	152 673	2 071	2 806
2024	146 917	197 264	2 622	3 563
2025	182 094	244 516	3 188	4 343
2026	191 028	255 845	3 212	4 388
2027	199 469	266 554	3 235	4 432
2028	207 407	276 628	3 258	4 476
2029	214 835	286 057	3 281	4 518
2030	221 754	294 839	3 303	4 559

Note: GDP figures reported at constant 2019 prices in millions of euros. Employment figures reported in thousand persons.

At a more disaggregated level, the impacts of the two policy options on real value added show a uniformly positive effect across sectors. Table 9 to Table 14 present the impact of policy options 1 and 2 on real value added by sector in percentage deviations and absolute values deviating from the baseline. The impacts are generally more pronounced under policy option 2: Coordinated approach compared to the ones for policy option 1: Common approach. The computed absolute impacts for policy option 2 exceed those for policy option 1, reflecting the respective percentage deviations from the CGE model. The magnitude of the impacts grows over time, which is an indication that the benefits of implementing the policy options considered can be expected to materialise gradually. The results by sector suggest that sizable absolute effects may be observed in trade, transport, public services and healthcare, in terms of both real value added and employment.

There is some heterogeneity in the magnitude of the impacts. The trade and transport sector, the 'other services'[256] sector and financial and insurance activities show the largest impacts towards the end of the simulation period. The highest impact is expected to be for the 'other services': the anticipated deviation from the baseline is calculated to be at 2 % in 2030. In absolute values, the highest expected difference of real value added compared to baseline is calculated to be for trade sector: €48 595 million (1.6 % in percentage deviations from baseline) in 2030.

Conversely, the smallest deviations from baseline are expected in the public services (0.6 % in 2030), construction (1 % in 2030), and information and communication sectors (1.1 % in 2030) under policy

[256] The term 'other services' is used is used as a shorthand reference to sector 'Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies'.

option 1. Under Scenario 2 the smallest deviations are calculated for public services (0.7 % in 2030), manufacturing (1 % in 2030), and information and communication (1.2 % in 2030) sectors under Scenario 2.

Table 13 and Table 14 show the sectoral deviations of total factor productivity from the baseline paths of the variable in policy options 1 and 2, respectively. Similarly to the impacts on other indicators, the estimated impacts are more pronounced under the policy option 2. These directly reflect the expectations of the Delphi method respondents on how innovation and efficiency gains will evolve relative to the baseline. They also incorporate the assumption that the effects will reach full strength in a five-year horizon and stabilize thereafter. Under the Common Approach (policy option 1), industry (0.58 % in 2030), professional services (0.44 % in 2030) and trade and transport (0.42 % in 2030) are expected to post the highest increases in total factor productivity relative to the baseline. The smallest deviations are calculated to be for manufacturing, information and communication, and 'other services'. With the Coordinated Approach (policy option 2), industry, professional services and public services are expected to record the highest deviations, while the smallest total factor productivity deviations are forecasted to be observed in information and communication, manufacturing, and trade and transport.

Table 9: Impact of implementing policy option 1 on real value added by sector (percentage deviations from baseline scenario values)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Agriculture, forestry and fishing	0.1	0.3	0.5	0.7	0.9	1.1	1.2	1.3	1.4	1.4	1.5
Industry (except construction and manufacturing)	0.3	0.6	0.8	1.1	1.4	1.6	1.6	1.6	1.6	1.6	1.6
Manufacturing	0.2	0.3	0.5	0.7	0.9	1.1	1.1	1.2	1.2	1.3	1.3
Construction	0.2	0.3	0.4	0.6	0.8	0.9	0.9	1.0	1.0	1.0	1.0
Wholesale and retail trade, transport, accommodation and food service activities	0.3	0.6	0.8	1.1	1.4	1.7	1.7	1.7	1.7	1.7	1.6
Information and communication	0.1	0.2	0.4	0.5	0.7	0.9	0.9	1.0	1.0	1.1	1.1
Financial and insurance activities	0.2	0.5	0.8	1.1	1.4	1.6	1.7	1.7	1.8	1.8	1.8
Real estate activities	0.2	0.5	0.7	1.0	1.2	1.5	1.5	1.5	1.6	1.6	1.6
Professional, scientific and technical activities; administrative and support service activities	0.2	0.3	0.5	0.7	0.9	1.1	1.1	1.2	1.2	1.2	1.3
Public administration, defence, education, human health and social work activities	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.6	0.6	0.6	0.6
Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies	0.2	0.5	0.7	1.0	1.3	1.6	1.7	1.8	1.8	1.9	2.0

Table 10: Impact of implementing policy option 1 on real value added by sector (deviations from baseline scenario values, constant 2019 prices, millions of euros)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Agriculture, forestry and fishing	285	686	1 114	1 580	2 084	2 627	2 880	3 132	3 384	3 636	3 890
Industry (except construction and manufacturing)	1 064	2 185	3 289	4 435	5 632	6 889	7 005	7 098	7 170	7 221	7 252
Manufacturing	3 031	7 039	11 220	15 703	20 482	25 552	27 443	29 283	31 071	32 803	34 481
Construction	944	1 976	3 030	4 147	5 325	6 563	6 849	7 111	7 348	7 562	7 753
Wholesale and retail trade, transport, accommodation and food service activities	6 424	13 944	21 340	28 906	36 643	44 560	45 586	46 502	47 308	48 006	48 595
Information and communication	681	1 620	2 630	3 739	4 950	6 264	6 821	7 365	7 895	8 413	8 916
Financial and insurance activities	1 413	3 211	5 030	6 930	8 911	10 971	11 521	12 062	12 593	13 113	13 623
Real estate activities	2 922	6 402	9 919	13 616	17 501	21 585	22 490	23 345	24 150	24 906	25 612
Professional, scientific and technical activities; administrative and support service activities	2 171	4 849	7 636	10 640	13 868	17 328	18 143	18 970	19 806	20 650	21 501
Public administration, defence, education, human health and social work activities	2 055	3 477	5 241	7 451	10 104	13 199	14 250	15 130	15 834	16 359	16 701

Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies	839	2 035	3 264	4 561	5 926	7 359	7 901	8 442	8 981	9 516	10 049

Table 11: Impact of implementing policy option 2 on real value added by sector (percentage deviations from baseline scenario values)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Agriculture, forestry and fishing	0.2	0.5	0.8	1.1	1.4	1.8	1.9	2.0	2.1	2.2	2.3
Industry (except construction and manufacturing)	0.4	0.7	1.0	1.3	1.7	2.0	2.0	2.0	2.0	1.9	1.9
Manufacturing	0.1	0.3	0.4	0.5	0.7	0.8	0.9	0.9	1.0	1.0	1.0
Construction	0.3	0.6	1.0	1.3	1.7	2.0	2.1	2.2	2.3	2.3	2.4
Wholesale and retail trade, transport, accommodation and food service activities	0.4	0.9	1.4	1.8	2.3	2.8	2.8	2.8	2.8	2.8	2.9
Information and communication	0.1	0.2	0.3	0.5	0.7	0.9	0.9	1.0	1.1	1.2	1.2
Financial and insurance activities	0.4	0.7	1.1	1.5	1.9	2.3	2.4	2.4	2.5	2.5	2.5
Real estate activities	0.3	0.5	0.8	1.0	1.3	1.6	1.6	1.6	1.6	1.6	1.6
Professional, scientific and technical activities; administrative and support service activities	0.2	0.4	0.6	0.8	1.1	1.3	1.3	1.3	1.3	1.4	1.4
Public administration, defence, education, human health and social work activities	0.2	0.2	0.3	0.4	0.6	0.7	0.7	0.7	0.7	0.7	0.7

Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies	0.3	0.8	1.3	1.7	2.2	2.7	2.8	2.9	3.1	3.2	3.3

Table 12: Impact of implementing policy option 2 on real value added by sector (deviations from baseline scenario values, constant 2019 prices, millions of euros)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Agriculture, forestry and fishing	483	1 132	1 814	2 549	3 341	4 190	4 531	4 875	5 225	5 580	5 944
Industry (except construction and manufacturing)	1 301	2 651	4 001	5 427	6 939	8 549	8 707	8 840	8 948	9 032	9 093
Manufacturing	2 570	5 537	8 710	12 210	16 037	20 192	21 862	23 444	24 935	26 332	27 633
Construction	1 663	4 137	6 648	9 262	11 976	14 790	15 722	16 637	17 533	18 412	19 274
Wholesale and retail trade, transport, accommodation and food service activities	9 872	22 616	35 211	48 094	61 274	74 767	77 216	79 563	81 809	83 954	86 000
Information and communication	532	1 403	2 391	3 521	4 796	6 220	6 986	7 739	8 480	9 207	9 920
Financial and insurance activities	2 033	4 624	7 223	9 921	12 714	15 602	16 322	17 030	17 725	18 406	19 072
Real estate activities	3 337	7 008	10 753	14 745	19 002	23 542	24 399	25 195	25 930	26 603	27 213
Professional, scientific and technical activities; administrative and support service activities	2 713	5 841	9 095	12 617	16 420	20 518	21 226	21 928	22 624	23 311	23 989

Public administration, defence, education, human health and social work activities	3 275	5 278	7 628	10 519	13 965	17 978	18 596	18 973	19 105	18 984	18 608
Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies	1 362	3 420	5 518	7 712	10 003	12 389	13 305	14 225	15 150	16 078	17 009

Table 13: Impact of implementing policy option 1 on total factor productivity by sector (percentage deviations from baseline scenario values)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Agriculture, forestry and fishing	0.05	0.11	0.16	0.21	0.27	0.32	0.32	0.32	0.32	0.32	0.32
Industry (except construction and manufacturing)	0.10	0.19	0.29	0.39	0.48	0.58	0.58	0.58	0.58	0.58	0.58
Manufacturing	0.03	0.07	0.10	0.14	0.17	0.21	0.21	0.21	0.21	0.21	0.21
Construction	0.06	0.12	0.18	0.24	0.30	0.36	0.36	0.36	0.36	0.36	0.36
Wholesale and retail trade, transport, accommodation and food service activities	0.07	0.14	0.21	0.28	0.35	0.42	0.42	0.42	0.42	0.42	0.42
Information and communication	0.05	0.10	0.14	0.19	0.24	0.29	0.29	0.29	0.29	0.29	0.29
Financial and insurance activities	0.06	0.12	0.17	0.23	0.29	0.35	0.35	0.35	0.35	0.35	0.35
Real estate activities	0.05	0.11	0.16	0.22	0.27	0.32	0.32	0.32	0.32	0.32	0.32
Professional, scientific and technical activities; administrative and support service activities	0.07	0.15	0.22	0.29	0.37	0.44	0.44	0.44	0.44	0.44	0.44

Public administration, defence, education, human health and social work activities	0.07	0.13	0.20	0.26	0.33	0.39	0.39	0.39	0.39	0.39	0.39
Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies	0.05	0.11	0.16	0.21	0.26	0.32	0.32	0.32	0.32	0.32	0.32

Table 14: Impact of implementing policy option 2 on total factor productivity by sector (percentage deviations from baseline scenario values)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Agriculture, forestry and fishing	0.09	0.18	0.28	0.37	0.46	0.55	0.55	0.55	0.55	0.55	0.55
Industry (except construction and manufacturing)	0.12	0.23	0.35	0.47	0.58	0.70	0.70	0.70	0.70	0.70	0.70
Manufacturing	0.07	0.14	0.21	0.28	0.35	0.42	0.42	0.42	0.42	0.42	0.42
Construction	0.09	0.17	0.26	0.34	0.43	0.51	0.51	0.51	0.51	0.51	0.51
Wholesale and retail trade, transport, accommodation and food service activities	0.07	0.14	0.21	0.28	0.35	0.42	0.42	0.42	0.42	0.42	0.42
Information and communication	0.06	0.12	0.19	0.25	0.31	0.37	0.37	0.37	0.37	0.37	0.37
Financial and insurance activities	0.08	0.16	0.24	0.31	0.39	0.47	0.47	0.47	0.47	0.47	0.47
Real estate activities	0.08	0.17	0.25	0.34	0.42	0.51	0.51	0.51	0.51	0.51	0.51
Professional, scientific and technical activities; administrative and support service activities	0.10	0.20	0.30	0.40	0.50	0.60	0.60	0.60	0.60	0.60	0.60
Public administration, defence, education, human health and social work activities	0.09	0.19	0.28	0.37	0.47	0.56	0.56	0.56	0.56	0.56	0.56
Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies	0.07	0.15	0.22	0.30	0.37	0.44	0.44	0.44	0.44	0.44	0.44

It is expected that the implementation of either policy option will have a significant impact on employment. This is also reflected in the deviations of employment at the sectoral level, which are uniformly positive (to a varying degree) under both policy options (see Table 15 to Table 18). Notably, the responses in the Delphi method questionnaire indicate that both the supply and the demand for labour can be expected to increase if one of the policy options is implemented. As both factors work in the same direction, the total labour market response is amplified. The magnitude of the impacts grows over time, which is an indication that the benefits of implementing the policy options considered can be expected to materialise gradually. The results by sector suggest that sizable absolute effects may be observed in trade, transport, public services and healthcare, in terms of employment.

Under the Common Approach policy option, the largest impacts on employment are expected to be observed in construction (4.9 % or 428 000 people in 2030), agriculture (3.9 % or 240 000 people) and trade and transport (3.6 % or 1.216 million people). The smallest deviations from baseline under policy option 1 are forecasted to materialize in information and communication (0.9 % or 25 000 people in 2030), professional activities (0.9 % or 160 000 people) and the 'other services' sector (1.4 % or 115 000 people).

Policy option 2 envisages the smallest deviations to be observed in information and communication, manufacturing and public services. In 2030 the deviations will reach 0.7 %, 0.8 % and 1.4 % respectively. In absolute values, these would result in 49 000 more people compared to baseline in information and communication sector in 2030, 46 000 and 845 000 more people in manufacturing respectively.

The most significant deviations are expected in construction (9.3 % in 2030), agriculture (6.8 %) and trade and transport (5.6 %). It should be noted that the latter impacts are substantial, especially in construction, and therefore are better interpreted as an upper bound on the expected employment deviations, rather than the most probable outcome.

The computed impacts for policy option 2 exceed those for policy option 1, reflecting the respective percentage deviations from the CGE model. The magnitude of the impacts grows over time, which is an indication that the benefits of implementing the policy options considered can be expected to materialise gradually. The results by sector suggest that sizable absolute effects may be observed in trade, transport, public services and healthcare, in terms of both real value added and employment.

Table 15: Impact of implementing policy option 1 on employment by sector (percentage deviations from baseline scenario values)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Agriculture, forestry and fishing	0.5	1.1	1.7	2.3	2.9	3.5	3.6	3.6	3.7	3.8	3.9
Industry (except construction and manufacturing)	0.4	0.9	1.4	1.9	2.3	2.8	2.8	2.9	2.9	3.0	3.0
Manufacturing	0.3	0.6	0.8	1.1	1.4	1.7	1.7	1.7	1.7	1.7	1.7
Construction	0.6	1.4	2.1	2.8	3.6	4.4	4.5	4.6	4.7	4.8	4.9
Wholesale and retail, transport, accommodation and food service activities	0.6	1.2	1.7	2.3	2.9	3.5	3.5	3.5	3.6	3.6	3.6
Information and communication	0.1	0.3	0.4	0.5	0.7	0.8	0.9	0.9	0.9	0.9	0.9
Financial and insurance activities	0.4	0.8	1.2	1.6	1.9	2.3	2.3	2.3	2.3	2.3	2.4
Real estate activities	0.3	0.6	1.0	1.3	1.6	1.9	1.8	1.8	1.8	1.8	1.7
Professional, scientific and technical activities; administrative and support service activities	0.1	0.3	0.4	0.5	0.7	0.8	0.9	0.9	0.9	0.9	0.9
Public administration, defence, education, human health and social work activities	0.3	0.6	0.9	1.2	1.5	1.9	1.9	1.9	1.9	1.9	1.9
Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies	0.3	0.6	0.8	1.1	1.3	1.6	1.6	1.5	1.5	1.4	1.4

Table 16: Impact of implementing policy option 1 on employment by sector (deviations from baseline scenario values, thousand persons)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Agriculture, forestry and fishing	31	66	101	138	176	215	219	224	229	234	240
Industry (except construction and manufacturing)	9	19	30	40	51	61	62	63	64	65	66
Manufacturing	54	110	166	223	280	338	338	337	336	335	334
Construction	54	117	180	245	313	384	392	401	410	419	428
Wholesale and retail trade, transport, accommodation and food service activities	186	380	572	768	969	1 176	1 185	1 194	1 202	1 209	1 216
Information and communication	5	10	16	21	27	33	34	34	35	35	35
Financial and insurance activities	12	24	36	48	61	74	74	74	74	74	74
Real estate activities	4	9	13	17	21	26	25	25	25	24	24
Professional, scientific and technical activities; administrative and support service activities	20	43	67	92	118	145	148	151	154	157	160
Public administration, defence, education, human health and social work activities	89	187	286	388	493	602	604	606	608	610	612
Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies	24	47	68	90	112	134	130	126	122	119	115

Table 17: Impact of implementing policy option 2 on employment by sector (percentage deviations from baseline scenario values)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Agriculture, forestry and fishing	0.9	1.8	2.8	3.8	4.8	5.9	6.1	6.2	6.4	6.6	6.8
Industry (except construction and manufacturing)	0.5	1.1	1.6	2.2	2.7	3.3	3.3	3.4	3.4	3.4	3.4
Manufacturing	0.1	0.3	0.4	0.5	0.7	0.8	0.8	0.8	0.8	0.8	0.8
Construction	1.4	2.8	4.3	5.8	7.4	9.1	9.1	9.2	9.2	9.3	9.3
Wholesale and retail trade, transport, accommodation and food service activities	1.0	1.9	2.8	3.8	4.7	5.7	5.7	5.6	5.6	5.6	5.6
Information and communication	0.1	0.2	0.3	0.4	0.5	0.6	0.6	0.6	0.7	0.7	0.7
Financial and insurance activities	0.6	1.1	1.7	2.3	2.8	3.4	3.4	3.4	3.4	3.4	3.4
Real estate activities	0.3	0.7	1.1	1.5	1.9	2.2	2.3	2.3	2.4	2.4	2.4
Professional, scientific and technical activities; administrative and support service activities	0.2	0.4	0.6	0.8	1.1	1.3	1.3	1.4	1.4	1.5	1.5
Public administration, defence, education, human health and social work activities	0.2	0.5	0.7	0.9	1.2	1.4	1.4	1.4	1.4	1.4	1.4
Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies	0.5	0.9	1.3	1.8	2.2	2.6	2.5	2.4	2.3	2.2	2.1

Table 18: Impact of implementing policy option 2 on employment by sector (deviations from baseline scenario values, thousand persons)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Agriculture, forestry and fishing	41	88	136	186	239	294	300	307	314	322	331
Industry (except construction and manufacturing)	11	26	40	55	69	83	85	87	88	90	91
Manufacturing	72	148	224	302	381	461	462	462	462	461	460
Construction	72	157	243	333	426	523	536	549	563	576	590
Wholesale and retail trade, transport, accommodation and food service activities	246	510	772	1 041	1 317	1 602	1 620	1 636	1 651	1 665	1 678
Information and communication	6	14	21	29	37	45	46	47	48	48	49
Financial and insurance activities	16	32	49	66	83	100	101	102	102	102	103
Real estate activities	6	12	17	23	29	35	35	34	34	34	33
Professional, scientific and technical activities; administrative and support service activities	26	58	90	124	160	198	202	207	211	216	221
Public administration, defence, education, human health and social work activities	117	251	387	526	671	820	825	830	835	840	845
Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies	32	63	92	122	152	182	178	173	168	163	158

3.5. What are the (qualitative) impacts of various policy options on European added value?

Section 3.2 addressed the potential European added value of creating and improving the ethical framework for artificial intelligence. The following table summarises the estimated level of impact, on a qualitative level, given the policy options discussed in section 3.3.

Table 19: Qualitative level of impact of policy options per EU added value

EU Added value	Status quo	Scenario 1	Scenario 2	Discussion points
Increasing social acceptance	-	++	+++	As noted in the survey for this assignment, many experts and practitioners that we approached believed that the EU played an important role in increasing social acceptance. Quantitatively, scenario 2 was seen to have the highest impact. A more localised approach, which can take into account local sensitivities and beliefs, can help to explain why impacts of scenario 2 are seen to be higher than scenario 1.
Emphasising a competitive niche	+	+++	++	Given that European legislation around the ethics of artificial intelligence and data are in early stages, researchers are still collecting data to measure the impacts. It is expected, however, that these frameworks will impact the shape of the market and – depending on the specificity of the provisions – can promote new business models and potentially influence not meeting ethical standards from operating within European boundaries. A unified approach build off of the digital single market would likely have a higher impact, but both policy options present benefits.
Facilitating pan-European datasets	0	+	0	A consistent ethical framework will remove some barriers for inconsistencies across Member States, but as noted in section 3.1, obstacles to a single digital market when it comes to data faces many other obstacles than data protection and privacy or other ethical issues. It is anticipated that an ethical framework will have only a minor impact.
Providing legal certainty	--	++	+	A consistent legal framework across Member States will make it easier for both developers and users to operate with legal certainty. Differing legal standards across the European Union on ethical considerations would make it more difficult for European companies to understand what standards they should adhere too so that they can easily operate within the entire digital single market.
Projecting EU values	0	+++	++	As noted in in section 3.1, there is already some evidence that new standards being created by European policymakers are influencing jurisdictions outside of Europe. Scenario 1, which provides a more unified view, would increase that impact.

4. Insights and takeaways

One point of contention in the debate over ethical artificial intelligence is that creating a regulatory framework will impede European industry looking to develop new and innovation solutions. These same concerns have been raised in regard to the GDPR, though few studies exist to substantiate the claims that GDPR creates a significant economic negative to the European economy, as mentioned earlier in this report. In fact, the evidence presented in this report suggests that this narrative is false. An ethical framework would provide a net benefit, both from an economic perspective as well as for some of the 'softer' added value, such as projecting European values globally. Europe has an important and positive policy role to play.

Given the clear importance that an ethical framework can provide, it may appear counter-intuitive that the analysis shows that Europe should have a shared approach, but not necessary one supported by legislation – at least when considering the economic benefits that a framework can provide. Indeed, some of the more qualitative added values of a unified ethical such as protection of fundamental rights and projecting European values on a world stage are weaker in scenario 2, where Member States have some flexibility to adapt the framework to local circumstances. Nevertheless, given that beliefs over social rights differ across Member States – including importantly for emerging rights, such as data privacy – it perhaps makes sense that an approach that acknowledges national competence in protecting social rights and ethics may be more effective.

This final chapter explores the differences across the two scenarios in further details, exploring details around proportionality, subsidiarity, economic benefits, as well as social and fundamental rights.

4.1. Proportionality and subsidiarity

The principles of proportionality and subsidiarity call for unified European action only in cases where individual actions of Member States do not lead to better results. These actions should also not be stronger than necessary to resolve a specific problem.[257] In terms of ethical considerations, the ideas of proportionality and subsidiarity are relatively complex to disentangle given the sheer number of ethical situations that could apply. Nonetheless, the EU competences to carry out either of the policy options are based on Article 4 TFEU. At least the following areas of the shared competence are relevant:

257 Ballegooij, Wouter van and Tatjana Evas (2016). An EU mechanism on democracy, the rule of law and fundamental rights. European Added Value Assessment accompanying the legislative initiative report (Rapporteur: Sophie in't Veld). EPRS Study.

1. Ensuring free movement of goods and services incorporating AI, robotics and related technologies by removing technical, legal and administrative barriers (internal market),
2. Ensuring consumer protection – especially where automated decision-making is in place,
3. Encouraging research, development and innovation and cooperation in these areas across Member States.

As evidenced from both the qualitative and quantitative analysis, proportionality and subsidiarity depend on which challenges legislation would be looking to resolve, with argumentation existing for both scenarios.

4.2. Political feasibility

Given the disagreement within the survey conducted for this study, and the differences across Member States in terms of emerging rights, it is reasonable to assume that scenario 2 would be the more politically feasible option. A November 2019 survey by Eurobarometer, for example, showed relatively wide disparities across Member States when it came to concerns around whether artificial intelligence could be used to discriminate against people. In the Netherlands, 57 percent of respondents indicated that it was a concern, while in Estonia, only 17 percent of respondents showed concern.[258] Given the perception, as mentioned in earlier in this report, that some stakeholders believe that emerging ethical considerations such as data privacy hinder economic growth and development of innovation applications in the field, it is reasonable to assume that settling on an ethical framework that has sufficient force may face some debate. This would also help to explain why respondents to the survey disagreed on the effectiveness of European intervention and will have ranked scenario 2 – where European countries will have greater leeway to adopt stricter standards according to the local situation and beliefs – would lead to greater social acceptance.

4.3. Economic potential

As demonstrated in section 3.4 on page 52 of this report, the economic potential for an ethical framework for artificial intelligence and robotics is clear. All scenarios analysed and presented as a part of this report show a net benefit to both GDP and employment within an ethical framework. As mentioned in the analysis, a more flexible approach would lead to greater economic benefits. While the legal certainty that firms would be provided would likely provide a nominal benefit, respondents to the survey indicated that much of the economic benefit would accrue from greater social acceptance of artificial intelligence, which would lead to greater uptake of new and innovative technologies. Given the social acceptance of technologies would be rely on some of the differing cultural norms across the European Union, one can assume that an approach that centres on the Member State would be more effective in reducing barriers to uptake.

4.4. Social and fundamental rights

While not explicitly discussed in detail in the report, it remains important to understand that ethics are broader than social and fundamental rights. Ethics can apply to every action, even those that

[258] Kantar (2019). Europeans and Artificial Intelligence. Standard Eurobarometer 92.

may not be classified as rights that Europeans have come to understand. As such, an ethical framework touches on more than just social and fundamental rights.

There is an argument to be made that standard rights across the European Union, as captured by scenario 1, would lead to clearer protections for European citizens. However, each scenario looks to further protect and entrench social and fundamental rights. It is important to note, however, that fundamental rights are ultimately protected by the EU Charter of Fundamental Rights.

4.5. Concluding insights

While the report has identified five unique points of added value for European regulation, the most significant according to stakeholders and experts is the idea of social acceptance. Some respondents viewed the potential for an eventual pushback against artificial intelligence applications that are viewed with mistrust as a threat to the industry.[259] European legislation has a role to play in fostering trust through ethics and fundamental rights. Any ethical framework which is eventually agreed should be viewed through this prism.

While this study has demonstrated that Europe has a positive role to play, it does not illustrate or test specific actions that should be taken, as mentioned in section 3.3 on page 48. Rather, it has focussed on the concepts that would feed into an eventual ethical framework. These positive effects would only appear with well-thought out legislation that is implemented consistently.

This study would also confirm that a European approach to ethical artificial intelligence – one that encourages social acceptance of the technology – would provide a net benefit to both developers and to the overall European economy. And, according to the analysis, the stronger that regulatory framework, the clearer the benefits (as per the added benefits of scenario 2, as discussed in the report). A pan-European approach that reflects the digital single market is vital for the health of the industry moving forward.

[259] Currently, not much data exists to understand consumer sentiment towards artificial intelligence. One study from 2019 suggests that artificial intelligence is largely portrayed positively, but this study focussed on English language (and American) media and is more than one year old in a field with rapidly change sentiments. See Garvey, Colin, and Chandler Maskal (2019). Sentiment Analysis of the News Media on Artificial Intelligence Does Not Support Claims of Negative Bias Against Artificial Intelligence. *OMICS: A Journal of Integrative Biology* 24: 5, pp. 286–299.

Annex I: Delphi method

The objective of the Delphi method was to gather quantitative estimates of ethical framework on the economy. Therefore it enriches the information collected through desk review presented in Chapter 2. The Delphi method was chosen because it was specifically developed and successfully deployed to forecast and assess complex issues when data are not available. In addition, it allowed to collect information of geographically separated experts and was conducted online.

Description of the Delphi process

To collect information on the sizes of the impacts on various indicators of the ethical framework, we employed the Delphi method with three iterations. Figure 2 presents the process of the Delphi method that we used for this study. We contacted a number of experts to secure their involvement in the process. In the meantime, we drafted the questionnaire for the first iteration. It contained a series of questions on the sizes and directions of the impact on the economy for the selected sectors, taking into account what inputs are necessary for the CGE model and the results of the literature review. The final version of the questionnaire was agreed with the client and afterwards sent to the experts. After the experts completed the surveys, the data were collected and analysed for consensus. For the questions where no consensus was reached, we prepared a follow-up questionnaire explaining the results of the first iteration and fed it back to the expert panel. Afterwards, the results were collected and checked for consensus again taking into account the answers of experts from the first iteration that did not provide answers to the second iteration. The answers from the two iterations of the Delphi were used to determine the sizes of the shocks on the economy given different scenarios. For questions on the effects of productivity and innovation, one more iteration was conducted since the model simulation produced unrealistic results. The difference in questions was only in the magnitude of a possible impact on productivity or innovation. Once the experts responded to the questions, the results were collected and analysed. These results were used to determine the size of the shocks on productivity and innovation.

Figure 2. Delphi process employed for this study

Note: for the third iteration, steps 4 and 5 were repeated.

Expert selection process

The experts were selected based on their proven knowledge of the deployment and development of innovations in AI, robotics and related technologies in their sector of expertise. Knowledge on ethical issues regarding AI or possible ethical policy approaches to AI in their respective sectors was not required. While a frequent size of an expert panel for the Delphi method is 20 persons, we aimed to have five experts for the eight selected sectors[260] – agriculture, automotive, construction, energy, financial services, health, telecom and transport. The experts were identified and approached during May-June 2020.

The identification of experts was the result of an accurate process of desk research. Per sector, the project team created a mapping of the most important and relevant stakeholders at EU level, and in some instances at national level, in the framework of sector innovation and AI application. These included:

1. Business associations;
2. Sector associations;
3. Public institutions, especially relevant EU institutions;
4. Universities and other research institutes;
5. European Commission expert groups;
6. Temporary, recurring or one-off EU workgroups, projects, workshops, conferences and other relevant events.

An important parameter in the identification was to have a balanced mix of academics, policymakers, practitioners and business/sector representatives. For each sector, an initial list of approximately 10 to 15 qualified experts was composed. These experts were informed via e-mail about the study and the Delphi method conducted as part of it, and were asked to confirm their participation in the two rounds of surveys. In case of no response, follow-up calls to the experts were made some days after the e-mail invitation – if an expert's telephone number was available. For a number of sectors, additional experts had to be identified – in most sectors 30 to 35 experts had to be approached. Finally, for the automotive industry, no more than two of the 40 approached experts indicated their willingness to participate. In total, 245 experts were identified and approached in the process.

Response rate to the Delphi survey

The first survey ran from 9 June until 19 June. In total, 43 experts confirmed their willingness to participate during the identification phase, 42 experts started filling out the first survey iteration, and 38 experts completed the first survey iteration. The second survey targeted all responding experts from the first survey iteration, and ran from 23 June until 28 June. 38 experts who participated in the first survey iteration were approached again, of which a total of 25 experts responded. The third iteration ran between 17 and 27 July. All experts with confirmed willingness to participate were contacted during this stage. Out of them, 28 experts responded to the third iteration of the Delphi survey.

Table 20: Overview of the number of confirmed and responded experts to the Delphi survey

Sector	Number of confirmed experts	Number of respondents to 1st iteration	Number of respondents to 2nd iteration	Number of respondents to 3d iteration
Agriculture	6	6	5	6
Automotive	2	6	4	4

[260] A frequent size of an expert panel for the Delphi method is about 20 persons, but many studies have been conducted with significantly larger groups, and scholars point out specifically that there is no upper limit for expert participants. The downside of having a large number of expert participants is that it would take more time to analyse data. We aim to identify at least 5 experts per sector for this study in order to have a larger pool to select from and to have back-up possibilities.

Construction	7	5	3	3
Energy	5	4	2	2
Finance	6	6	2	1
Health	5	5	3	4
Telecom	5	3	2	3
Transport	7	7	4	5
Total	43	42	25	28

Questionnaire design

The questionnaire for the first iteration of Delphi contained 10 questions per scenario. In total, there were two scenarios included in addition to the questions on the current situation (or status quo). Estimating the European Added Value for ethical AI combines components of both forecasting (i.e. what the likely impacts of ethical AI would be, possibly by comparison to unfettered AI, in the future) and assessment (i.e. the level of / the extent of the impacts, quantified where possible).

All questions asked about an impact on a certain characteristic of the economy in five years from now in the three situations. Such characteristics include the output capacity of a sector, demand for the sector's products, and demand and supply of labour in the sector, innovation and investments in a sector environmental degradation, sectoral integration and emergence of a new sub-sector. To avoid placing high cognitive burden on the experts, we envisage a narrow menu of options for the modes of application of ethical principles, e.g. comprehensive application of ethical principles to achieve close to the maximum potential and a more limited mode of application that is close to the status quo.

Each question had a scale of the size of the impact:

1 Increase substantially (for example, a further 5 to 10 % increase);
2 Increase moderately (for example, a further 1 to 5 % increase);
3 Remain roughly unchanged;
4 Decline moderately (for example, a further -1 to -5 % decrease);
5 Decline substantially (for example, a further -5 to -10 % decrease).

For each question, experts were given the option to select 'other, please specify' as an alternative response. This option was added to allow for collection of feedback on the granularity, multitude and size of the impacts. In addition, this enabled identification of areas that were unclear and required further clarification. The questions were the same across the different sectors.

The results of the first iteration of the Delphi method were collected and analysed for consensus. The consensus was determined in advance as having at least 65 % of experts in certain sector agreeing on the direction of the impact. Those questions where consensus was reached, were not included in the next iteration of Delphi. The exception to this rule concerned the questions on environment degradation, sectoral integration and emergence of new sub-sector. This was done to avoid placing high cognitive burden on the experts and since these variables could not be included in the CGE model. In addition, the experts in telecommunication sector reached a consensus already in the first round, therefore in the second round they were asked to provide the reasons for choosing a certain answer only.

In the iteration two, the experts received a customised survey across the two scenarios and the status quo situation. The customisation was applied per sector, presenting the collective response to each question (the share of respondents selecting a certain answer) and asking participants to select one of the answer options selected in the first iteration besides 'other, please specify' answer option. Participants were asked to (re)consider their responses in light of the group's responses. As a follow-up question, the respondents were asked to explain why they selected a certain answer.

After the second iteration was completed, the answers to both iterations were analysed to calculate the size of the impact of certain characteristics on the economy of a certain sector given the two scenarios and the status quo. The answers provided as 'other' were cleaned to be included as one of the other answer categories since the respondents provided a response specifying the details of the effect, providing more granularity that could not be accounted in the model.

The answers to the second iteration were combined with the answers of respondents that only provided answers to the first iteration to determine the level of consensus between the experts. The share of respondents providing a certain answer was used as a weight to calculate the size of the impact on the sector of the economy. It was assumed that when selecting 'increase or decrease substantially', the size of the impact would be 7.5 % (the average between 5 % and 10 %); when selecting 'increase or decrease moderately', the size of the impact would be 3 % (the average between 1 % and 5 %); when selecting 'remain roughly unchanged', the size of the impact would be 0. Multiplying the weight with the assumed size of the impact resulted in the size of the impact used in the model when quantifying the situation in five years depending on a scenario.

After the size of the shocks were calculated, we cross-checked them with the explanations provided by the respondents. There might have been a misunderstanding when choosing answers to the questions comparing productivity and innovation changes in five years from now. The comparison was not between the situation of now and in five years, but between two alternative states of the world in five years from now. In addition, the questions on number of job openings, demand for products, number of persons willing to take up the work are rather tangible compared to questions on productivity, innovation and transparency. Therefore, we decided to ask the questions about productivity and innovation in policy options 1 and 2 compared to status quo and policy option 1 respectively to eliminate potential bias in responses.

The questionnaire for the third iteration was kept short and contained four questions. The questions covered the size of an impact compared to the baseline and policy option 1 and presented a scale of answer options that was derived from the consensus between experts. This scale was similar to the first and second iterations, but the ranges of the impacts were smaller:

1. Remain roughly unchanged compared to the status quo or policy option 1;
2. Increase minimally compared to the status quo or policy option 1 (0.1 %-0.3 %);
3. Increase moderately compared to the status quo or policy option 1 (0.3 %-0.5 %);
4. Increase substantially compared to the status quo or policy option 1 (0.5 %-1 %).

Once the responses were collected, a size of the shock was calculated for policy option 1 (2) compared to the situation in status quo (policy option 1). The weights for each answer category were estimated using the share of respondents selecting a certain answer option. These weights were multiplied by the average anticipated size of the impact.

Annex II: Macroeconomic modelling

This annex provides an overview of the structure of the quantitative model employed for the assessment of the impact of identified policy options. The impact of the policy options is estimated using a computable general equilibrium model (CGE). The model was enhanced with dynamic equations that allow the computation of the impact of a set of shocks over a specified time horizon. The model structure features an open economy with a sectoral breakdown that is tailored to the specific analytical requirements at hand. The model also includes a government sector. It is calibrated on recent data for the EU economy.

The theoretical structure of the model follows the one described in WIK-Consult, Ecorys and VVA Consulting (2016).[261] It is assumed that the economy is divided in sectors, each producing a specific product.[262] We present the main model components below. In order to use suggestive notation, whenever possible we use the subscript i to refer to products, the subscript j to refer to sectors and t denotes time. Time in the model is discrete and the time step is assumed to be one year.

Household

The household in the model consumes a bundle of the products in the economy and supplies two types of labour (skilled and unskilled). It is described by the following per-period utility function:

$$U_t = \sum_{i=1}^{n} \theta_i \ln C_{it} - \sum_{j=1}^{n} \xi_j \frac{N_{jt}^{\rho+1}}{\rho+1} - \sum_{j=1}^{n} \pi_j \frac{H_{jt}^{\rho+1}}{\rho+1} + \kappa \ln S_t.$$

Here C_{it} is the consumption of a product i in period t, N_{jt} is unskilled labour supplied in a sector j, H_{jt} is skilled labour supplied in a sector j and S_t is household savings.

The household faces the following budget constraint:

$$\sum_{i=1}^{n} P_{it} C_{it} = (1-td) \sum_{j=1}^{n} (PN_{jt} N_{jt} + PH_{jt} H_{jt} + PKPR_{jt} KPR_{jt}) + ror \cdot A_t + tr_t - S_t,$$

where P_{it} is the price of product i, including indirect taxes, td is the (implicit) direct tax rate on income, and PN_{jt} and PH_{jt} are respectively the prices of unskilled and skilled labour in a sector j. It is assumed that the return on private capital KPR_{jt} in sector j is transferred to the household through the rental rate $PKPR_{jt}$. Additionally, the household receives interest ror on its assets A_t and transfers from the government tr_t.

The household's problem is to maximize utility U_t with respect to C_{it}, N_{jt}, H_{jt} and S_t subject to the above budget constraint.

Representative firm in sector

The representative firm in a sector j strives to maximize profit by employing skilled and unskilled labour, as well as renting public and private capital. Its profit function is

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[261] WIK-Consult, Ecorys and VVA Consulting (2016). Support for the preparation of the impact assessment accompanying the review of the regulatory framework for e-communications. Study for the European Commission.

[262] Sometimes sectors are referred to as 'activities', while products are referred to as 'commodities', following established terminology in the CGE literature.

$$\Pi_{jt} = PVA_{jt}VA_{jt} - PN_{jt}N_{jt} - PH_{jt}H_{jt} - PKPR_{jt}KPR_{jt} - PKPU_{jt}KPU_{jt},$$

where PVA_{jt} is the price of value added, VA_{jt} is the real value added produced and $PKPU_{jt}$ is the rental rate of public capital KPU_{jt} in sector j.

The production technology available to the firm is a two-level one. First, skilled and unskilled labour are combined through a constant elasticity of substitution (CES) aggregator to produce the overall labour input L_{jt}:

$$L_{jt} = \sigma_{jt}^{L}\left(\beta_j^L N_{jt}^{\nu_j^L} + (1-\beta_j^L)H_{jt}^{\nu_j^L}\right)^{\frac{1}{\nu_j^L}}.$$

Similarly, public and private capital stocks are combined though a CES-type aggregator to obtain the total capital input K_{jt} for the sector:

$$K_{jt} = \sigma_{jt}^{K}\left(\beta_j^K KPU_{jt}^{\nu_j^K} + (1-\beta_j^K)KPR_{jt}^{\nu_j^K}\right)^{\frac{1}{\nu_j^K}}$$

Second, value added is produced by means of a production function that in turn combines L_{jt} and K_{jt}. The specific form of the production function is given by

$$VA_{jt} = \sigma_{jt}^{VA}\left(\beta_j^{VA} L_{jt}^{\nu_j^{VA}} + (1-\beta_j^{VA})K_{jt}^{\nu_j^{VA}}\right)^{\frac{1}{\nu_j^{VA}}}.$$

The variable σ_{jt}^{VA} is total factor productivity for sector j. Its evolution over time is described in the following sections.

Foreign trade aggregators

The supply Q_{it} of a product i on the domestic market is formed by combining imports of the product, denoted QM_{it}, and quantities QD_{it} produced locally for the domestic market (Armington assumption). Formally, the composite product aggregator is given by

$$Q_{it} = e_i\left(\beta_i QM_{it}^{-\sigma_i} + (1-\beta_i)QD_{it}^{-\sigma_i}\right)^{-\frac{1}{\sigma_i}}.$$

The inputs to the above aggregator are determined through a cost minimization problem that produces the optimal mix between domestically produced and imported products:

$$\frac{QM_{it}}{QD_{it}} = \left(\frac{PD_{it}}{pm_{it}\frac{\beta_i}{1-\beta_i}}\right)^{\frac{1}{1+\sigma_i}}.$$

Here pm_{it} is the price of imports of commodity i and PD_{it} is the domestic price.

The domestically produced quantities of product i, denoted QP_{it}, are either exported or supplied locally. The allocation constraint between the domestic and export markets is

$$QP_{it} = f_i\left(\eta_i QE_{it}^{\gamma_i} + (1-\eta_i)QD_{it}^{\gamma_i}\right)^{\frac{1}{\gamma_i}},$$

where QE_{it} is the quantity for the export market.

The optimal allocation between domestic and exported products is again obtained through solving an appropriate cost minimization problem, which results in the relationship

$$\frac{QE_{it}}{QD_{it}} = \left(\frac{pe_{it}}{PD_{it}}\frac{1-\eta_i}{\eta_i}\right)^{\frac{1}{\gamma_i - 1}},$$

with pe_{it} denoting the export price of product i.

Government

The government in the model collects revenues R_t from direct taxes, indirect taxes (at the implicit rate of τ_i per product i), the return on public capital and the return on net government assets AG_t:

$$R_t = \quad td \sum_{j=1}^{n} (PN_{jt}N_{jt} + PH_{jt}H_{jt} + PKPR_{jt}KPR_{jt}) + \sum_{i=1}^{n} \tau_i \frac{P_{it}}{1+\tau_i} Q_{it} + \sum_{j=1}^{n} PKPU_{jt}KPU_{jt} + ror \cdot AG_t.$$

Government expenditures G_t are allocated between three spending categories: purchases of product i, transfers to households and capital expenditures KE_t. Formally, government expenditures are given by the equation

$$G_t = \sum_{i=1}^{n} P_{it} cg_{it} + tr_t + KE_t,$$

where cg_{it} denotes the volume of purchases of product i.

The budget balance BB_t is given by

$$BB_t = R_t - G_t.$$

The budget balance is accrued to net government assets AG_t to ensure intertemporal consistency, as explained in the section on model dynamics.

Model closure and equilibrium

Foreign savings in the model are defined from the standpoint of the external sector. Thus, revenues for the external sector comprise the domestic economy imports and interest on the net foreign assets AF_t (again vis-a-vis the domestic economy). Expenditures are computed as the sum of nominal domestic exports by product. Foreign savings FS_t are given by the equation

$$FS_t = \sum_{i=1}^{n} pm_{it}QM_{it} + ror \cdot AF_t - \sum_{i=1}^{n} pe_{it}QE_{it}.$$

We also impose the typical requirement that the total supply of each product is equal to its uses. This is implemented by means of the supply-use balancing equation

$$Q_{it} = \sum_{j=1}^{n} IC_{ijt} + C_{it} + cg_{it} + ID_{it} + QE_{it} + QT_{it},$$

where IC_{ijt} is intermediate consumption of product i by sector j, ID_{it} is investments demand and QT_{it} is use of product i to cover trade and transport margins.

It is assumed that savings and investment are balanced at the sectoral level, with nominal investment for sector taken as part of total saving, using the share of sectoral capital in the total capital stock as the proportionality coefficient. The savings-investment balancing equation takes the form

$$\overline{PK}_t II_{jt} = \frac{K_{jt}}{\sum_{j=1}^{n} K_{jt}} (S_t + KE_t + BB_t + FS_t - ror(A_t + AF_t + AG_t) - \sum_{i=1}^{n} P_{it} Z_{it} - DUMMY_t),$$

where II_{jt} denotes sectoral investment in real terms, Z_{it} is the change in inventories of product i and the variable $DUMMY_t$ plays a technical role and should be zero in equilibrium.

$$\text{plevel}_t = \sum_{i=1}^{n} w_i P_{it}.$$

Dynamics

Agents in the model optimize intratemporally. However, the model contains a set of dynamic equations that ensure consistent evolution of variables over the specified time horizon. These include stock-flow relationships and the dynamics of total factor productivity.

Public capital by sector is taken to evolve over time according to a standard capital accumulation equation:

$$KKPU_{j\,t+1} = (1 - \delta) KKPU_{jt} + IPU_{jt}.$$

Here stands for the annual depreciation rate and is public investment in sector .

Private capital follows the same type of law of motion:

$$KKPR_{j\,t+1} = (1 - \delta) KKPR_{jt} + IPR_{jt},$$

with IPR_{jt} denoting private investment in the sector j.

The change in private sector assets reflects savings. The accounting identity is

$$A_{t+1} = A_t + S_t.$$

Similar accounting identities hold true for foreign assets and government assets:

$$AF_{t+1} = AF_t + FS_t,$$

$$AG_{t+1} = AG_t + BB_t.$$

Finally, total factor productivity changes in the basis of an exogenously specified growth rate γ_t^A:

$$\sigma_{j\,t+1}^{VA} = (1 + \gamma_t^A) \sigma_{jt}^{VA}.$$

Model calibration

Most of the model coefficients are calibrated using public data from Eurostat, with a limited number of coefficients calibrated on theoretical grounds with values taken from the relevant literature. The bulk of the calibration is implemented by constructing a social accounting matrix (SAM) that measures the flows between the different institutional sectors of the economy for a selected base year. Additional data-based calibrations outside the SAM framework were carried out again using Eurostat data.

In order to ensure reproducibility of the computations and facilitate future updates of the model, the calibration process was implemented through a system of R language[263] scripts. These scripts sequentially carry out the following steps:

1. Automatic retrieval of the necessary data tables from the Eurostat website;
2. Sectoral aggregation according to a predefined grouping and temporal aggregation for a selected set of years;
3. Aggregation of country-level data to the EU level or to another predefined regional grouping;
4. SAM balancing and coefficient computation.

Specifically, the following tables are downloaded from the Eurostat database for use in the calibration exercise:

1. `naio_10_cp15;`
2. `naio_10_cp16;`
3. `gov_10a_main;`
4. `gov_10a_exp;`
5. `lfsa_eisn2;`
6. `earn_ses14_49.`[264]

The inputs required for the model calibration have been constructed for an approximation of the EU economy. This is done by aggregating data on 24 EU countries (Croatia, Estonia and Sweden are excluded due to data constraints, and the UK is not considered). As the model exploits the structure of the data rather than the absolute numbers, this level of coverage is considered satisfactory.

The calibration year is taken to be 2016, which is deemed to be an acceptable compromise between recency and coverage. Notably, while a single year was used in this case to give prominence to the most recent period of acceptable coverage, the system in principle allows for the use of average values over several years.

The sectoral aggregation for economic sectors and products corresponds to the A*10 industry breakdown of NACE, revision 2, and matches the prior analysis and industry structure used for the Delphi method.

The SAM, as directly constructed from the statistical data sources, is unsuitable for CGE modelling, since the presence of statistical discrepancies will violate accounting identities in the model. It is therefore necessary to distribute these discrepancies so that the SAM is balanced (row sums are

263 https://www.r-project.org/

264 The following data were downloaded: Supply table at basic prices incl. transformation into purchasers' prices, Use table at purchasers' prices, Government revenue, expenditure and main aggregates, Central government expenditure by function, Employment by occupation and economic activity, Mean annual earnings by sex, economic activity and occupation respectively. The tables were last accessed in June 2020.

equal to column sums). There exist different balancing procedures and for this modelling exercise the procedure recommended by Hosoe et al. (2010),[265] chapter 4, is used. This procedure is readily implementable by optimization software and helps ensure consistency in the balancing approach across datasets and calibration updates. More specifically, the procedure for balancing the SAM involves the following problem:

$$\min_{x_{kl}} \sum_{k} \sum_{l} \left(\frac{x_{kl} - x_{kl}^{0}}{x_{kl}^{0}} \right)^{2}$$

subject to

$$\sum_{l} x_{kl} = \sum_{l} x_{lk}, \ \forall k,$$

where x_{kl} denotes the entry in the k-th row and l-th column of the adjusted matrix, while x_{kl}^{0} is the corresponding entry in the unadjusted SAM, taken as a parameter. The procedure is applied to the non-zero entries of the original SAM.

At the end of the calibration procedures, a balanced SAM and an additional set of model parameters are available to be provided as input for the main model code.

Shock construction

Delphi results transformation

The aggregated Delphi method results provide input for the CGE model for five types of shocks: labour demand, labour supply, product demand, investment, and total factor productivity (TFP). While the information from the Delphi method can be mapped directly to the first four categories of shocks, the TFP effect needs to be constructed by combining the answers to several questions from the survey.

The strategy chosen for constructing the TFP effect was to adjust the answers to the questions on productivity and innovation by the reported effect of increased transparency, and then weight the adjusted data to obtain the final size of the TFP effect. The size of the effect on productivity and innovation after the adjustment for transparency is given by

$$\bar{E}_{jr} = E_{jr}(1 + T_j),$$

where $\bar{E}_{jr}$ is the adjusted effect for sector (industry) j and question $r = \{\text{productivity}, \text{innovation}\}$, and T_j stands for the reported change in transparency.

The size of the TFP effect for a sector j is then computed according to the formula

$$TFP_j = \sum_{r} w_r \bar{E}_{jr}.$$

The weights w_r were chosen on the basis of the literature on the diffusion of innovation, which consistently places the share of innovators plus early adopters in the 10-15 % range, while various

[265] Nobuhiro Hosoe, Kenji Gasawa and Hideo Hashimoto (2010), 'Textbook of Computable General Equilibrium Modelling: Programming and Simulations', Palgrave Macmillan.

forms of followers/late adopters take the balance.[266] In this context we take the maximum value of 15 % as the weight of the innovation question from the survey, while the residual weight of 85 % is used for the productivity question.

The industries covered by the Delphi survey form a representative subset of the A*10 NACE breakdown used in the CGE model. It is therefore necessary to construct a mapping between the Delphi industries and the economic sectors included in the model. In most cases the mapping can be done directly, while for certain sectors the size of the effect needs to be constructed synthetically by combining the responses for several sectors. The following table presents the sectoral mapping between the Delphi survey and the CGE model.

266 See, e.g. chapter 7 in Rogers, E.M. (2003), Diffusion of Innovations, 5th edition, Free Press; Mirvis, P.M. (1997), 'Human Resource Management: Leaders, Laggards and Followers', *The Academy of Management Executive*, vol. 11, No. 2, pp. 43-56 or Stiglitz, J.E. (2014), 'Leaders and Followers: Perspectives on the Nordic Model and the Economics of Innovation', NBER WP 20493.

Table 21: Sectors covered and derived effects

NACE code	NACE description	Delphi industry	Derived effects
A	Agriculture, forestry and fishing	Agriculture	-
B, D_E	Industry (except construction and manufacturing)	Energy sector	-
C	Manufacturing	Automotive industry	-
F	Construction	Construction	-
G_I	Wholesale and retail trade, transport, accommodation and food service activities	Transport	-
J	Information and communication	Telecom and e-communications	-
K	Financial and insurance activities	Finance	-
L	Real estate activities	-	0.5*F + 0.5*K
M_N	Professional, scientific and technical activities; administrative and support service activities	-	0.5*K + 0.5*M_N
O_Q	Public administration, defence, education, human health and social work activities	Healthcare	-
R_U	Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies	-	0.25*G_I + 0.25*K + 0.25*K + 0.25*O_Q

The TFP construction method and the sectoral mapping described above were applied to each of the three scenarios (Baseline (status quo), policy option 1: Common approach and policy option 2: Coordinated approach) covered by the Delphi method questionnaire.

Shock size computation

The results from the Delphi questionnaire provide two types of inputs for the CGE model. First, the responses to the questions on the evolution of the respective industry in the absence of policy changes are used to calibrate the baseline scenario in the model. These involve computing the TFP path in the baseline, as well as shocks to the relevant model coefficients in a 5-year horizon. Second, the responses to the counterfactual questions that assume various forms of policy interventions are used to compute the deviations of the model variables in the two policy options from the values in the baseline path.

The effects computed from the Delphi questionnaire are partial effects for the respective sector and are therefore applied to calibrate the size of the shocks through the relevant equations in the model (i.e. demand function for a particular product, demand and supply functions for different types of labour etc.). In all cases the computation of the shock size takes the following general form. Let X_k

denote a variable of interest (e.g. the quantity of a product demanded) and X_{-k} denotes the rest of the model variables. Likewise, let α_m denote the coefficient to be shocked and α_{-m} denote the other coefficients in the model. In the baseline, a model equation will take the form

$$F_i(X_k, X_{-k}; \alpha_m, \alpha_{-m}) = 0.$$

If the relevant effect from the Delphi method is denoted by Δ_k, then the corresponding size of the shock is computed as the value ϵ_m that solves the equation

$$F_i(X_k(1+\Delta_k), X_{-k}; (\alpha_m + \epsilon_m), \alpha_{-m}) = 0.$$

Since the Delphi responses report the expected partial effects in a 5-year horizon, appropriate assumptions are needed about the evolution of the effects over the entire simulation horizon of the model. To this end, the following approach was implemented.

For the baseline, on the basis of the Delphi responses average annual changes of TFP per sector were computed. These changes were applied for the entire simulation horizon up to 2030. For the other shocks we assumed that the maximal size of the impact is reached in 2025 and retained thereafter. For the periods up to 2025 the size of the shocks was computed by linear interpolation starting from the first year of the simulation, 2020.

For the two policy options, the size of the effects is reported in the Delphi method relative to an alternative path (the baseline in the case of policy option 1, and policy option 1 in the case of policy option 2). Thus, the Delphi responses for policy option 2 were first rebased to be relative to the baseline instead of to policy option 1. Second, the shocks were calibrated to produce the corresponding deviations from the baseline in 2025 using the rebased Delphi effects. For each shock, it was again assumed that the maximal size of the impact is reached in 2025 and then kept constant until the end of the simulation horizon. For the periods up to 2025 the size of the shocks was computed by linear interpolation, as explained above.

Quantification of the impacts in absolute values

The computation of the effects of the policy options under consideration in absolute terms requires the values of the respective variables in the baseline scenario. The country coverage of the CGE model, while sufficient for the purpose of approximating the structure of the EU-27 economy, precludes the direct use of the baseline from the model. Moreover, the baseline scenario from the CGE model does not take into account cyclical fluctuations in the variables induced by shocks such as the COVID-19 pandemic. Therefore, the values of the variables of interest in the baseline need to be obtained through additional computations.

The values throughout 2020 and 2030 in the baseline for total employment, nominal and real GDP were calculated in the following way, as presented in Table 22. We use the respective values for 2019 from Eurostat as a starting point (specifically datasets nama_10_gdp and lfsa_eisn2 for the latest available data). The nominal GDP values for 2020 and 2021 are computed using the real GDP growth and GDP deflator projections from the Spring 2020 Economic Forecast of the European Commission.[267] The nominal GDP values for 2022-2030 are computed by applying the average annual nominal GDP growth for the period 2000-2019. The real GDP and total employment are calculated in the same way.

[267] European Commission (2020) Spring 2020 Economic Forecast, available at https://ec.europa.eu/commission/presscorner/detail/en/ip_20_799.

Table 22: Applied calculation of the values of economic indicators throughout 2019-2030 for the construction of the baseline in absolute values

Economic indicator	Value in 2019	Value in 2020-2021	Value in 2022-2030
Total employment Nominal and real GDP	Eurostat value for 2019	Projections calculated in the Spring 2020 Economic Forecast of the EC[267]	Value in the preceding year is multiplied by the average growth rate for the period 2000-2019
Employment per sector Nominal and real GDP per sector	Eurostat value for 2019 per sector	Calculated indicator for the whole economy multiplied by the sector share of 2019	Calculated indicator for the whole economy multiplied by the sector share of 2019

In the absence of projections for nominal value added, real value added and employment by sector, the respective baseline paths are constructed using the computed baseline values of nominal GDP, real GDP and employment and applying the assumption of constant structure over time, using the respective sector shares from 2019. This enables the use of the most recent data available to account for the sectoral structure of the economy. A limitation of this approach is that it cannot capture sectoral differences in cyclical or structural developments in the baseline. This limitation is partially mitigated by the fact that such structures are relatively slow changing.
The computation of the absolute deviations for the respective variables is carried out by applying the percentage deviations from baseline of real GDP, real value added and employment as obtained from the CGE model to the baseline paths described above and rescaling appropriately to ensure additivity of the sectoral results to the total. In the case of nominal variables, the absolute deviations are computed by applying the percentage deviations for the respective real variables.

The calculated impacts in absolute values on nominal variables are presented in the tables below.

Table 23: Impact of implementing policy options 1 and 2 on nominal GDP (absolute deviations from baseline scenario values)

	Policy option 1	Policy option 2
2020	24 741	33 031
2021	54 509	73 153
2022	86 099	115 626
2023	120 729	162 118
2024	158 539	212 870
2025	199 691	268 145
2026	212 890	285 126
2027	225 907	301 885
2028	238 712	318 381
2029	251 278	334 581
2030	263 583	350 453

Note: GDP figures reported at current prices in millions of euros.

Table 24: Impact of implementing policy option 1 on nominal value added by sector (deviations from baseline scenario values, millions of euros)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Agriculture, forestry and fishing	305	747	1 232	1 776	2 381	3 049	3 397	3 755	4 123	4 503	4 896
Industry (except construction and manufacturing)	1 070	2 230	3 412	4 676	6 035	7 501	7 751	7 982	8 195	8 388	8 562
Manufacturing	2 995	7 059	11 438	16 269	21 563	27 337	29 837	32 358	34 895	37 444	40 002
Construction	1 029	2 188	3 410	4 744	6 190	7 751	8 222	8 675	9 111	9 530	9 931
Wholesale and retail trade, transport, accommodation and food service activities	6 482	14 282	22 217	30 584	39 398	48 684	50 617	52 477	54 259	55 960	57 576
Information and communication	656	1 585	2 615	3 779	5 083	6 536	7 233	7 938	8 649	9 366	10 090
Financial and insurance activities	1 323	3 051	4 858	6 803	8 889	11 120	11 868	12 629	13 400	14 182	14 975
Real estate activities	3 034	6 747	10 626	14 823	19 361	24 266	25 695	27 108	28 501	29 874	31 224
Professional, scientific and technical activities; administrative and support service activities	2 210	5 011	8 020	11 357	15 043	19 099	20 324	21 596	22 917	24 285	25 700
Public administration, defence, education, human health and social work activities	2 129	3 657	5 602	8 094	11 155	14 807	16 246	17 531	18 647	19 581	20 318
Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies	861	2 119	3 455	4 906	6 478	8 174	8 920	9 686	10 472	11 278	12 105

Table 25: Impact of implementing policy option 2 on nominal value added by sector (deviations from baseline scenario values, millions of euros)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Agriculture, forestry and fishing	516	1 228	1 999	2 856	3 803	4 847	5 327	5 826	6 345	6 887	7 456
Industry (except construction and manufacturing)	1 305	2 697	4 138	5 703	7 410	9 277	9 603	9 909	10 194	10 458	10 699
Manufacturing	2 532	5 535	8 850	12 608	16 827	21 530	23 691	25 821	27 911	29 956	31 949
Construction	1 810	4 566	7 458	10 559	13 874	17 412	18 811	20 230	21 668	23 126	24 603
Wholesale and retail trade, transport, accommodation and food service activities	9 935	23 091	36 537	50 716	65 661	81 417	85 456	89 490	93 518	97 537	101 546
Information and communication	512	1 368	2 370	3 546	4 909	6 470	7 384	8 314	9 258	10 216	11 188
Financial and insurance activities	1 899	4 380	6 954	9 706	12 641	15 763	16 760	17 772	18 799	19 840	20 894
Real estate activities	3 456	7 362	11 481	15 999	20 952	26 379	27 785	29 160	30 500	31 802	33 064
Professional, scientific and technical activities; administrative and support service activities	2 755	6 016	9 521	13 423	17 752	22 541	23 699	24 883	26 091	27 322	28 576
Public administration, defence, education, human health and social work activities	3 384	5 532	8 127	11 390	15 366	20 101	21 131	21 912	22 424	22 646	22 561
Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies	1 394	3 550	5 821	8 268	10 898	13 716	14 970	16 267	17 606	18 990	20 419

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The EU can become a global standard-setter in the area of artificial intelligence (AI) ethics. Common EU legislative action on ethical aspects of AI could boost the internal market and establish an important strategic advantage. While numerous public and private actors around the globe have produced ethical guidelines in this field, there is currently no comprehensive legal framework. The EU can profit from the absence of a competing global governance model and gain full 'first mover' advantages. Building on the EU's economic and regulatory powers, common EU legislative action has great potential to provide European industry with a competitive edge. Furthermore, EU action can facilitate the adoption of EU standards globally and ensure that the development, uptake and diffusion of AI is based on the values, principles and rights protected in the EU. Those benefits cannot be achieved by actions of individual Member States. Thus, the success and benefits of EU action are contingent on the ability of the EU to take timely, common legislative action and to back this action up with strong democratic oversight, accountability and enforcement. The analyses of this European added value assessment suggest that a common EU framework on ethics has the potential to bring the European Union €294.9 billion in additional GDP and 4.6 million additional jobs by 2030..

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