EVIDENCE TO SUPPORT THE ANALYSIS OF IMPACTS FOR AI GOVERNANCE

Report Annexes

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CONTENTS

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Introduction

The annexes in this document provide a detailed explanation of the methodology, sources, assumptions and calculations of the analysis Frontier Economics produced for DCMS. These were the basis for the report “Evidence to support the analysis of impacts for AI governance”, Frontier Economics, May 2022 (from now on referred to as the main report).

Annex A – Quantitative Analysis

A.1 Introduction to modelling of the upstream AI market

As explained in the main report and these annexes, the quantitative analysis aims to calculate the costs of regulation and the wider beneficial impacts the AI regulation may create. In most analyses that try to approach the question of regulatory impact, the focus is on calculating the cost of compliance. This is an important first step to showing the overall economic burden of regulation on the sector. However, stopping there does not allow understanding of any further market impacts, such as any potential disproportionate impact on SMEs, compliance costs pass-through to consumers, the impact of prohibited AI systems, potential impacts on consumers' trust, and uncertainty in the market.

This approach was taken in the Study to Support an Impact Assessment of Regulatory Requirements for Artificial Intelligence in Europe (from now: Study to Support the EU AI Act Impact Assessment), which only calculated the total compliance costs in the European Union (EU).[1] Axle Voss has already published a request to review the Impact Assessment of the AI Act that criticises this narrow approach to impact assessment and points out the lack of consideration of impacts on SMEs and investments.[2] In our analysis, we were interested in understanding further impacts that might be created by AI regulation.

The market for AI products is complex, and this adds complexity to our modelling. It is possible to divide the market into three broad groups.

1. AI firms that sell AI products directly to end consumers.

2. AI firms that sell AI products to downstream firms to be used as inputs into products or improve the firm's efficiency.

3. Downstream, non-AI firms that develop AI in-house to either include it as part of their non-AI product or improve their efficiency.

AI regulation will affect all three groups. Ideally, one would look to model the impact of new regulation on each group in turn and then aggregate the impacts. Unfortunately, data limitations mean that it has been necessary to focus our modelling work on AI firms and, more specifically, the impacts on their revenues.

Whilst all three groups are captured in our modelling, the extent to which we believe we have captured the full effect of the potential regulation on each group varies. We discuss this further below.

[1] Study to Support an Impact Assessment of Regulatory Requirements for Artificial Intelligence in Europe. Available at: https://op.europa.eu/en/publication-detail/-/publication/55538b70-a638-11eb-9585-01aa75ed71a1

[2] https://www.kaizenner.eu/post/juri-draft-aia2

We start by recapping how regulation affects AI firms in our model (groups 1 and 2 above). In our model, we assess how compliance costs, market uncertainty, and consumer trust are expected to impact decisions for AI firms. Ideally, we would look at the value-added or removed from the economy as a result of these changes. This would combine the loss of productivity associated with the loss of revenue from AI firms, consumer surplus losses from lost AI purchases and any downstream productivity losses resulting from the reduced output of AI firms. It has not been possible to calculate all of these aspects separately due to data limitations. Therefore, we proxy these losses by looking at the changes in revenue for AI firms as a result of regulation. This does not capture productivity losses for AI firms or downstream firms that use AI, and it underestimates consumer losses by capturing only the lost value associated with AI purchases that no longer occur (and not the loss of surplus for consumers who still purchase but at higher prices). However, it potentially overstates consumer losses (including downstream businesses') if these consumers can substitute to other inputs to replace AI. Since AI is considered a unique input, and potentially difficult to substitute, we consider that the estimates likely underestimate the size of the impact. Further work could explore the impact of AI regulation on productivity impacts.

Evaluation of AI regulation's impact on the non-AI firms (group 3 above), poses a different set of challenges. These firms are operating in various downstream sectors throughout the economy, which means that evaluating the impact that compliance costs would have on their decision making (including investment decisions etc.) would require investigating many different markets. Although, in theory, it might be possible, it was not possible within the scope of our project. We, therefore, only estimate the total potential compliance costs for these firms within the scope of our work. Further investigation into how regulation would impact non-AI firms that develop AI products in-house might be another area of interest, particularly given the high number of firms that have previously been estimated to be part of this category.

Overall, we believe that this project attempts to unveil some of the more far-reaching and indirect impacts AI regulation may have on the AI market. The results of our analysis should be treated as indications rather than projections of future impact. The analysis highlights which areas might have the largest impacts and which areas are worth further investigation and consideration.

A.2 Model structure

This section provides a short overview of the general structure of the model, summarising the methodology underpinning the model structure and providing detailed steps of the calculations. The section covers the following explanations:

4. the general model structure;
5. the sequencing of model impacts; and
6. the baseline approach and figures.

A.2.1 General model structure

The model estimates key indicators such as revenues, number of firms and number of products in the AI market for the baseline scenario and the 2 alternative scenarios.[3] Figures in the baseline scenario are based on historical data, forecast until 2032 using historical growth rates. For scenarios 1 and 2, we estimate how these indicators change due to the impacts of regulation, compared to the baseline scenario.[4] The regulatory mechanisms estimated in this model are:

1. prohibition of certain AI products;
2. cost of complying with the regulation;
3. changes in consumer trust; and
4. changes in market uncertainty.[5]

The estimated impacts indicate how much AI market revenues are impacted through each of these channels. These impacts are estimated for both scenarios compared to the baseline.

A.2.2 General model structure

In scenarios 1 and 2, the impacts of regulation listed above originate from reactions by three types of actors: (i) AI firms, (ii) VC investors, and (iii) consumers. All decisions as a response to regulation (of business, investors, or consumers) eventually impact the level of AI revenues in the market. These changes are applied to the baseline levels of AI revenues and result in new AI revenues estimation depending on the scenario. The chronological order in which decisions are made and subsequent impacts occur is important. It is, therefore, crucial that we define the chronological order of these decisions in our model.

We mainly consider four different stages in our model:

1. **Phase 0: No actions** have occurred yet; all AI market statistics remain equal to the baseline figures.
2. **Phase 1: Firms and investors act**. Firms observe the regulation and the cost of complying. They decide how much of those costs they will pass through to consumers, whether they need to exit the market or not, and how much they want to deduct from their internal R&D investments. In parallel, VC investors observe the regulation and adjust the

[3] See sections A.3 - A.9 in the annex below for detailed explanations of the key indicators.

[4] See section 5 in the main report for a detailed explanation of scenarios 1 and 2.

[5] See section 6 in the main report and sections A.5 to A.12 in this annex for detailed explanations of the impact channels.

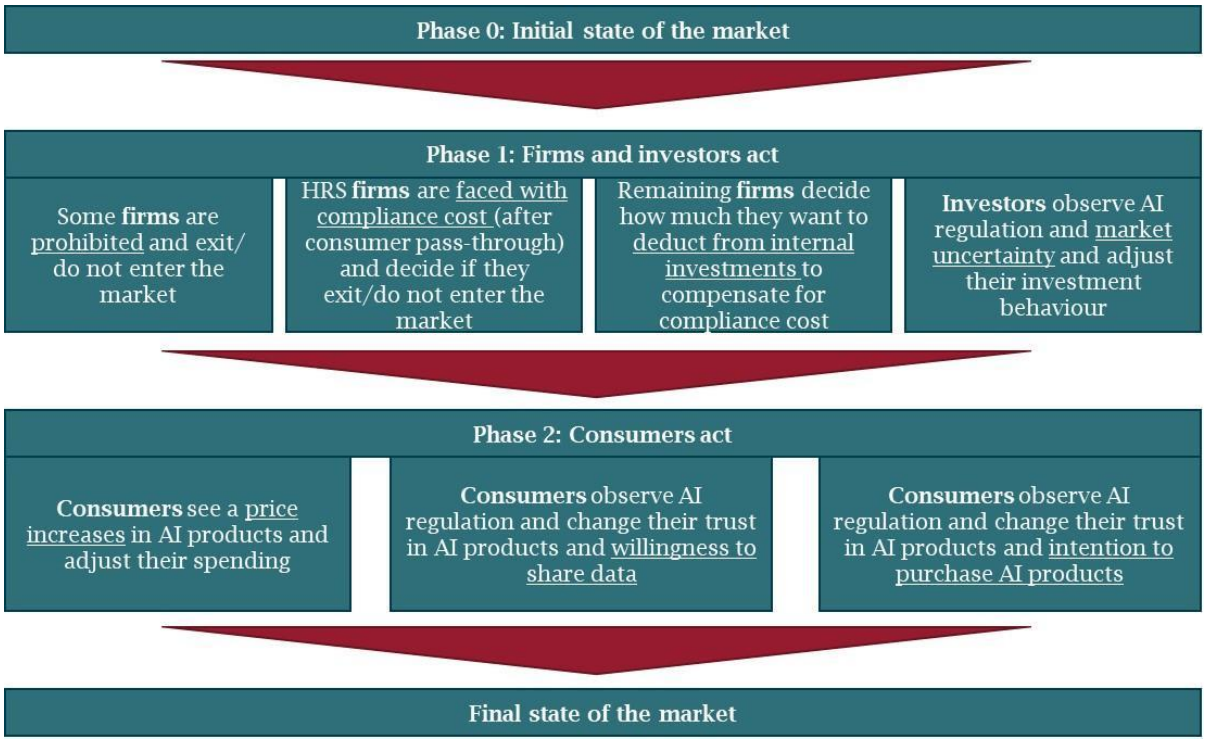
amount of money they are willing to invest into AI SME firms, which impacts revenues (returns from their investment) only the year after.[6]

3. **Phase 2: Consumers act**. They observe a price increase in AI products, based on the cost pass-through from AI firms, and decide by how much they want to adjust their spending. Additionally, they observe regulation and adjust trust towards AI products. This leads to a change in their willingness to share data, and consequently a change in overall productivity, and willingness to purchase AI products. Both of these reactions take into account the state of the market (i.e., market revenues) after phase 1.

4. **Final outcomes:** Captures the final state of the market where all actions and impacts have occurred.

Figure 1 A SCHEMATIC REPRESENTATION OF THE MODEL SEQUENCINGprovides a summary of the sequencing of impacts assumed in our model:

Figure 1 A SCHEMATIC REPRESENTATION OF THE MODEL SEQUENCING



Source: Frontier Economics

[6] In our model, the amount of VC investments depends both on an investment rate and on market revenues of the previous year (see section A.3.4 of the annex). If we were to assume that investors take into account the change in revenues caused by firms, we would not be able to isolate the impact of changes in the investment rate reflecting changes in investor uncertainty. We would only observe the joint impact of changed revenues caused by firm behaviour and investor uncertainty. To isolate the investor uncertainty impact, we assume that VC investors act independently of the decisions taken by the AI firms, and take into account baseline market revenues.

A.3 Baseline approach and figures

The baseline scenario is the starting point for our analysis. It captures the status-quo of the AI market, i.e., if no regulation were to be put in place in the UK, and the EU adopts the proposed EU AI act.[7] We use historical data for most key figures in the baseline scenario and project them into the future with assumptions on growth rates. In this section, we explain how we calculate the following market figures for the baseline scenario:

1. AI market revenues;
2. AI firms;
3. AI products; and
4. VC investments and ROI.

A.3.1 AI market revenues

To calculate the baseline figures on market revenues, we refer to the AI Activity in UK Businesses report (DCMS, December 2021) and go through the following steps: [8]

1. We retrieve the **total expenditure from UK businesses on AI technology**. In the AI Activity in UK Businesses report, these figures are based on survey data, extrapolated to the entire business population and projected until 2040. The total expenditure on AI products in 2020 was £16.7 billion.
2. We calculate the **total expenditure from UK businesses on AI products developed by AI firms (e.g., not developed in-house)**. The AI Activity in UK Businesses report mentions that 40% of all firms in 2020 directed their expenditure toward the in-house development of AI products rather than buying products from external developers. We, therefore, assume that only 60% of total AI expenditure by UK businesses goes towards external AI developers (i.e., AI firms). Those expenditures are considered to be the revenues generated by AI firms.
3. We calculate the **total revenues from AI products developed by domestic AI firms**. The AI Activity in UK Businesses report does not indicate what part of the expenditure flows to domestic developers versus developers outside the UK. We, therefore, proxy the share of imported AI products, using figures on GVA in the UK by the digital sector. In

[7] As explained in section 6.1.1 of the main report, the only impact assumed in the baseline scenario is trade friction that occurs due to the regulatory asymmetry between the UK and the EU (given that the EU would have AI-specific regulation and the UK will not). Since trade frictions are discussed separately in the quantitative analysis, we do not include any further modelling for the baseline scenario.

[8] AI Activity in UK Businesses report (DCMS, December 2021).

2019, the UK digital sector contributed £150.6 billion to the UK GVA (DCMS, 2019a).[9] In the same year, the digital sector imported £33.5 billion worth of services (DCMS, 2019b).[10] We, therefore, assume that 22% of expenditures on AI products by UK businesses go towards businesses outside the UK (i.e., imports). Thus, the remaining 78% of expenditure made by AI developers from UK businesses is attributed to the UK. We estimate UK AI market expenditure, which is assumed to be the AI firms' revenues (see step above) of £7.7 billion in 2020, increasing up to £24 billion in 2032.[11]

4. Finally, we split **total market revenues by firm size**. Based on evidence from the Data City report[12], we assume that 28% of total market revenues are attributed to small firms, 20% to medium-sized firms and 52% to large firms.[13] We can thus calculate AI-firm revenues by firm size from 2020 until 2032. Finally, we also compute the yearly growth of total revenues, which is used in later calculations. Table 1 shows market revenues by firm size in 2020, projected figures for the start of regulation in 2023, and projected figures for the last modelled year in 2032.

Table 1 Actual and projected AI market revenues in 2020, 2023 and 2032

Firm size	2020 revenues (actual)	2023 Revenues (Projected)	2032 Revenues (Projected)
Small	£2.19 bn	£3.20 bn	£6.84 bn
Medium	£1.60 bn	£2.33 bn	£4.99 bn
Large	£4.04 bn	£5.89 bn	£12.59 bn
Total	**£7.83 bn**	**£11.42 bn**	**£24.42 bn**

Source: Frontier Economics based on AI Activity in UK Businesses report.

Note: Our model estimates the impacts of regulation from 2023 until 2032. The years between 2023 and 2032 are not shown in this table.

A.3.2 AI firms

We consider AI firms in this model to be: firms that develop and sell AI products to businesses and consumers. To calculate the number of AI developers in the market every year in the baseline scenario, we go through the following steps:

[9] https://www.gov.uk/government/statistics/dcms-economic-estimates-2019-gross-value-added/dcms-economic-estimates-2019-provisional-gross-value-added

[10] https://www.gov.uk/government/statistics/dcms-sectors-economic-estimates-2019-trade-in-services/dcms-sectors-economic-estimates-2019-trade-in-services

[11] Estimates are based on the AI Activity in UK Businesses report central scenario for all the years in the modelling. Since all adjustments are applied in percentages on the baseline estimations, the final growth rate in our model is the same as in the AI Activity in the UK Businesses report.

[12] DCMS Internal analysis on strategic businesses undertaken by The Data City and Oxford Insights, 2021.

[13] DCMS Internal analysis on strategic businesses undertaken by The Data City and Oxford Insights, 2021.

1. We retrieve the **number of AI developers in 2020**. Estimates from Beauhurst suggest that in 2020 there were 1,506 AI developing companies headquartered in the UK.[14]

2. We split the **number of AI developers by firm size**. We rely on evidence from the Data City report,[15] which suggests that 82% of all AI firms are small, 14% are medium, and 4% are large. This is summarised in Table 2.

Table 2 Number of AI firms in 2020

Firm Size	Share of Total Firms	Number of Firms in 2020
Small	82%	1,240
Medium	14%	206
Large	4%	59
Total	**100%**	**1,506**

Source: Frontier Economics based on The Data City and Beauhurst.

3. We project the number of AI developers per firm size until 2032. We use the growth rate of AI market revenues. In particular, we assume that growth in AI market revenues is based on two factors: (i) growth in the number of AI firms in the market, and (ii) growth in the number of AI products available. To estimate the proportion of growth from each of these factors, we first estimate the growth rates of each, separately. Based on evidence from the Data City analysis, the growth in the number of AI firms is 9.4%, while the annual turnover growth of AI firms is 24.0% which is assumed to be from growth in the number of AI products. Assuming equal revenue in all AI firms, we use the ratio of the growth rates of the two factors to arrive at the estimation that 28% (9.4%/(9.4%+24%)=28%) of the growth in market revenues is due to growth in the number of AI businesses, while 72% (24%/(9.4%+24%)=72%) is due to growth in AI products. To estimate the yearly growth rate of AI firms, we multiply the yearly growth rates of AI revenues by 28%.

A.3.3 AI Products

It is important to distinguish between the number of product units sold on the market (i.e., quantity) and the number of unique product types available when referring to AI products. For this analysis, we consider the latter, since that is the basis on which firms need to comply with the regulation. Depending on the regulatory category, a firm would have to fulfil certain requirements for each unique type of product it develops. To estimate the number of unique products per firm as well as the total number of unique products on the market each year in the baseline scenario, we go through the following steps:

[14] DCMS has a subscription to the Beauhurst database of high-growth UK companies. This figure was sourced by DCMS in February 2022 by applying the following filters: Buzzwords = "Artificial Intelligence", Headquarters = "UK", Companies House status = "Active".

[15] DCMS Internal analysis on strategic businesses undertaken by The Data City and Oxford Insights, 2021.

1. We estimate the number of **unique products per firm size in 2020.** We assume that in 2020, small, medium, and large firms produce on average 2, 5 and 10 types of AI products, reflecting that larger firms offer a larger variety of products. This also resonates with what we have learned in stakeholder interviews.[16]

2. We project the estimated **number of unique product types per firm size category until 2032.** As explained in the previous section on AI firms, we assume that 72% of the year-on-year growth rate in AI market revenues is attributed to the growth rate in the number of unique AI products per firm.

3. Finally, we compute the **total number of AI products available on the market per firm size**, by multiplying the number of AI firms by the number of unique products per AI firm each year.

A.3.4 Venture capital (VC) investment and return on investment (ROI)

In our model, VC investment funds small and medium-sized firms to promote their growth, while large firms get funds from other sources.[17] We assume that a given amount of investment in one year generates additional revenues for SMEs in the next year, which is reflected by the ROI.[18] To calculate baseline VC investment, we go through the following steps:

1. We find the **yearly VC investment from 2019 until 2021**. We retrieve data from CrunchBase (Frontier Economics account) to identify VC funding rounds in 2019, 2020 and 2021 for SMEs in the UK AI market and aggregate them by year. We apply the following filter to the search:

   - Companies with headquarters in the UK;

   - Companies that are defined as "Artificial Intelligence" in CrunchBase; and

   - Funding received between 2019 and 2021 (inclusive).

   We find total investments of £1.32 billion in 2020.

2. We compute the **average annual growth rate between 2019 and 2021** and project the **VC investment figure until 2032 using the estimated year-on-year growth rate of 11.6%.**

[16] Assumption was agreed on with the DCMS team. It is expected the majority of this funding be internally raised.

[17] We mainly assume that they invest part of the revenues back into R&D.

[18] See section 6.1.5 in the main report and section A.9 in the annex for detailed calculations of investment impacts.

3. Finally, we estimate the **yearly return on investment (ROI).** We divide SMEs' profits in a given year by the VC investment of the previous year.[19]

Table 3 below presents the actual and projected values of VC investment as well as the ROI.

Table 3 Actual and projected VC investments and ROI

	2019 (actual)	2020 (actual)	2021 (actual)	2023 (Projected)	2032 (Projected)
VC investments	£1.03 bn	£1.32 bn	£1.26 bn	£1.57 bn	£4.21 bn
Year-on-year growth rate, 2019 – 2021	-	28.4%	-5.1%	-	-
Average growth, 2019 – 2021	11.6%		-		
ROI	-	37%	33%	39%	30%

Source: Frontier Economics, via CrunchBase.

Note: The ROI represents the profit returns in a given year due to VC investments in the previous year. To calculate annual profits, we apply an assumed profit margin of 10% on the market revenues estimated in the previous step. (Based on https://www.ons.gov.uk/economy/nationalaccounts/uksectoraccounts/datasets/profitabilityofukcompaniesreferencetable).

A.4 The Share of Firms Subject to Different Regulatory Requirements

Although regulatory categories would apply to products and not firms, for simplicity, we assume that AI firms would be fully prohibited.[20] In scenarios 1 and 2, firms fall under different regulatory requirements.

For scenario 1, we distinguish between:

1. prohibition;
2. HRS requirements;
3. transparency obligations for firms interacting with natural persons (non-HRS); and
4. voluntary codes of conduct.

For scenario 2, we distinguish between:

1. prohibition;

[19] To calculate annual profits, we apply an assumed profit margin of 10% on the market revenues estimated in the previous step. (https://www.ons.gov.uk/economy/nationalaccounts/uksectoraccounts/datasets/profitabilityofukcompaniesreferencetable).

We use market profits rather than market revenues to calculate the ROI, as we want to capture the "additional" revenues generated by investments, on top of those covering the firms' costs. Based on the data available, this is the closest proxy for ROIs we can produce.

[20] Mathematically reducing the proportion of businesses in full or removing the proportion of the products across all businesses would yield the same result assuming that the distribution of prohibited and HRS products would be uniformly distributed across AI firms.

2. HRS requirements; and

3. minimal requirements.

In the following section, we explain how we estimate the proportion of firms that fall under each regulatory requirement for each scenario.

A.4.1 Share of firms subject to regulatory requirements in scenario 1

Scenario 1 mirrors the EU AI Act, which categorises AI products and the regulation they should fall under based on the product's risk of violating human rights, and on its interaction with natural persons. The EU AI Act bases the risk level, among other criteria, on the sector in which the product is used.[21] The Study to Support the EU AI Act Impact Assessment[22] does not mention the method behind the estimates of the proportion of AI systems in each risk category. Our analysis, therefore, tries to provide an initial estimate based on knowledge of how AI can be applied in each sector and the likelihood of the sector, "contravening EU values, for instance by violating fundamental rights," or, "creating an adverse impact on people's safety or fundamental rights".

1. We, therefore, start by attributing levels of AI risk and interaction with natural persons to each sector. Table 4 summarises these assumptions.

Table 4 Levels of AI risk and interaction with natural persons per sector

SIC Industry	AI Risk Level	Natural Person Interaction Level	Number of AI firms
Agriculture, forestry and fishing	Low	Low	0
Mining and quarrying	Low	Low	0
Manufacturing	Medium	Low	168
Electricity, gas, steam and air conditioning supply	Medium	Low	12
Water supply; sewerage, waste management and remediation activities	Medium	Low	0
Construction	Medium	Medium	23
Wholesale and retail trade; repair of motor vehicles and motorcycles	Low	High	93
Transportation and storage	Medium	High	14
Accommodation and food service activities	Low	High	7
Information and communication	Low	Medium	2009
Financial and insurance activities	Medium	Medium	80
Real estate activities	Low	Low	19
Professional, scientific and technical activities	Medium	Medium	700
Administrative and support service activities	Medium	Medium	379

[21] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52021PC0206&from=EN

[22] Study to Support an Impact Assessment of Regulatory Requirements for Artificial Intelligence in Europe. Available at: https://op.europa.eu/en/publication-detail/-/publication/55538b70-a638-11eb-9585-01aa75ed71a1

Public administration and defence; compulsory social security	High	Medium	6
Education	High	High	23
Human health and social work activities	High	High	39
Arts, entertainment and recreation	Low	Medium	6
Other service activities	Low	Medium	80
Activities of households as employers; undifferentiated goods-and-services-producing activities of households for own use	Low	Medium	4
Activities of extraterritorial organisations and bodies	Low	Medium	79

Source: Risk and interaction levels provided by the DCMS. The number of AI firms per sector is provided by the Data City (2021).

Note: We note that the total number of AI firms in this table (3,741) does not match the total number of AI firms assumed in our baseline scenario (1,506). This is due to discrepancies between Beauhurst and The Data City's categorization of AI businesses. For this research, DCMS believes the Beauhurst number is more appropriate.

2. Next, each risk and interaction level is associated with a certain proportion of firms that will be prohibited, categorised as HRS, or subject to transparency obligations under scenario 1 – information provided by DCMS. Table 5 presents these assumptions.

Table 5 Shares of firms subject to prohibition, HRS or transparency requirements – scenario 1

Risk/Interaction level	Share of firms to be prohibited	Share of firms to be considered HRS	Share of Firms subject to transparency obligations
High	10%	40%	80%
Medium	5%	20%	50%
Low	2%	0%	30%

Source: Figures provided by the DCMS

3. We calculate the number of firms that are prohibited, HRS or subject to transparency obligations (due to interaction with a natural person) for scenario 1. We multiply the attributed percentages for each category in each sector with the number of AI firms in the sector. We do not distinguish between small, medium and large firms, and we assume that the AI risks and levels of interaction with natural persons are distributed uniformly across firm sizes.

4. Finally, we calculate the total number of firms attributed to each regulatory requirement across sectors and divide it by the total number of firms (i.e., the total number of AI firms) to find the average share of firms subject to prohibition, HRS requirements and transparency obligations across all AI firms. The EU AI act encourages all remaining firms that do not fall under any of the three other categories, to apply voluntary codes of conduct. Since stakeholders and experts indicated that only firms already implementing such codes of conduct would comply with this voluntary code, we assume that it does not create further costs and exclude voluntary codes of conduct from our model. Table 6 shows the results of this exercise.

Table 6 Estimated shares of firms subject to scenario 1 regulations

Regulatory category	Average Share of Firms
Prohibition	3.25%
HRS requirements	8.08%
Transparency obligations	39.02%

Source: Frontier Economics.

A.4.2 Share of firms subject to regulatory requirements in Scenario 2

Regulation in scenario 2 includes the prohibition of some firms and the categorisation of some firms that fall under HRS requirements. The difference to scenario 1 is that existing sector regulators would be identifying prohibited and HRS products which would be outcome/result based rather than technology/sector-based as in scenario 1. Below we explain with which steps we calculate the shares for each regulatory requirement in scenario 2.

1. We apply a factor to the assumed share of firms associated with a particular risk level in scenario 1 (Table 7). We assume a factor of 0.5 for both the share of prohibited firms and the share of HRS firms for scenario 2 compared to scenario 1. This assumption is based on the fact that sectoral regulation should, in theory, provide a more accurate identification of prohibition and HRS firms. This assumption was confirmed by the DCMS team and our industry and expert engagement. Table 7 below presents those assumptions for scenario 2.

Table 7 Shares of firms subject to prohibition, HRS, or transparency requirements – scenario 2

Risk/Interaction level	Share of firms to be prohibited	Share of firms to be considered High Risk
High	5%	20%
Medium	2.5%	10%
Low	1%	0%

Source: Frontier Economics

Note: We use an adjusting factor of 0.5 compared to the assumed shares for scenario 1.

2. We then proceed with the same step as described for scenario 1 above to arrive at the total percentage of prohibited and HRS firms in the economy.

3. In scenario 2 we also need to assess who would need to comply with the minimal requirements. We assume that those firms which do not fall under prohibition and HRS requirements are subject to minimal requirements. While minimal requirements should apply to all firms alike, including HRS firms, we assume that prohibited firms would not need to comply with minimal requirements, and firms that already comply with HRS requirements would not need to duplicate any compliance effort for the minimal

requirements. Table 8 shows the different shares of firms that would fall under each of the three regulatory categories for scenario 2.

Table 8 Estimated shares of firms subject to scenario 2 regulations

Regulatory category	Average Share of firms
Prohibited	1.62%
High-risk requirements	4.02%
Minimal requirements	94.33%

Source: Frontier Economics

A.5 AI firms exiting or not entering the market due to prohibition

This section describes how the model estimates the impact of prohibiting certain AI products on AI market revenues. For simplicity, we assume that AI firms fall under prohibition in full and do not consider firms that may have a mix of prohibited and non-prohibited products. This simplification assumes that the distribution of prohibited products across firm sizes is similar across the economy and that the removal of a product would remove the equivalent proportion of their revenues (i.e., if a firm has two AI products and one is prohibited, it would remove half of their revenues).

To calculate the foregone revenues, we go through the following steps in each scenario:

1. We calculate the **average revenue per firm size for each year in the baseline scenario**. We divide the total baseline revenues for each firm size by the number of firms estimated for that size category.[23]

2. We calculate the **number of firms prohibited each year** by multiplying the total number of firms in each year by the share of prohibited firms calculated in the previous step.[24] As we assume that prohibited firms are distributed uniformly across firm sizes, the percentage of prohibited firms is applied equally to firms for each size.

3. We calculate the **foregone market revenues for each firm size** by multiplying the yearly number of prohibited firms by the average yearly revenue per firm size. The final figure represents the market revenues that would have been generated by prohibited firms absent any regulation, assuming that the AI risk (and thus the probability of being prohibited) is uniformly distributed across firm sizes.

[23] See section A.3.1 in the annex for the calculation of baseline market revenues.

[24] The number of prohibited firms can represent firms on the market that will exit (especially in the first year of regulation) as well as firms that would have entered absent any regulation, but will not do so because of prohibition. See section A.4.1 in the annex for the calculation of shares of prohibited firms.

A.6 Compliance costs per product and business

This section explains the calculation of compliance costs per unique product and AI firm, for each regulatory category and each scenario separately.

A.6.1 Compliance cost per product in Scenario 1

As previously explained, scenario 1 largely mirrors the EU Act. Therefore, we mainly rely on the compliance cost estimates provided by the EU AI Act Impact Assessment. In the following section, we explain how we produce estimates for HRS requirements and transparency obligations for firms interacting with natural persons in scenario 1.[25]

A.6.1.1 HRS firms

The EU AI Act Impact Assessment first considers 5 main categories of requirements for HRS firms' compliance under the EU AI Act. These are related to (i) training data, (ii) documents and record-keeping, (iii) robustness and accuracy, (iv) human oversight, and (v) information provision.[26] Additionally, the study considers costs for the conformity assessment procedure, i.e., the process of certification to verify that the product is compliant with the previous requirements. We explain below how we calculate compliance cost and conformity assessment procedure.

1. To calculate **compliance costs for the five HRS requirements** listed above, the study provides three types of cost factors. First, using a Standard Cost Model approach, they provide an estimate of minutes spent on each task by employees. This is then converted to hours and multiplied by a wage rate. Second, the study provides an estimate of FTE for procuring services and hiring additional staff to fulfil the requirements, which is also converted to monetary terms using a wage rate. Finally, the study provides cost amounts in Euro related to any additional expenditures required to comply with requirements. [27]

   In our model, we use the same estimates for minutes, FTEs and additional expenditure but diverge from the study in the following ways:

   a. Use the UK hourly wage for science, research, engineering and technology professionals in the 75% percentile for hourly wages.[28] This reflects our

[25] We assume that products falling under prohibition are not subject to any compliance cost. As explained in section A.6 of the annex we also assume no additional cost for voluntary codes of conduct.

[26] In the scope of this report, we refer to requirements (i)-(iii) as governance/management provisions and requirement (v) as transparency provision.

[27] Some examples of such expenditures are software purchases and external security services.

[28] We estimate an hourly wage of £30.35 based on ONS data, based on an annual wage of £54,379.

assumption that highly-skilled employees in the technology sector would be needed to fulfil regulatory compliance.[29]

b. We convert the additional expenditures into Pound Sterling.[30] It is assumed that this cost per HRS product does not vary across firm sizes.

The EU AI Act Impact Assessment assumes that some sectors incur lower costs than others due to preparedness from previous regulations such as the GDPR. In particular, they assume that firms in the IT sector only incur half of the costs estimated previously. Given that the businesses we consider in our model are all AI developing firms and thus can be considered to be part of the IT sector, we also reduce the estimated cost per product for the HRS requirements listed above by 50%.

Table 9 summarises the cost related to the five HRS requirements in scenario 1.

Table 9 Compliance cost per product for HRS requirements in scenario 1

	Training Data	Documents and record-keeping	Robustness and accuracy	Human oversight	Information provision	Total
Time estimates in minutes	5,181	2,231	4,750	1,620	6,800	20,582
Additional staff in FTE		0.05	0.05	0.1		0.2
Additional expenditure in EUR			€5,000	€500		€ 5,500
Time estimates in GBP*	£2,620	£1,128	£2,402	£819	£3,439	£10,409
Additional staff in GBP**		£2,761	£2,761	£5,523		£11,046
Additional expenditure in GBP***			£4,446	£445		£4,890
Sum of cost in GBP	£2,620	£3,890	£9,609	£6,787	£3,439	£26,345
Sum of cost adjusted for preparedness ****	**£1,310**	**£1,945**	**£4,805**	**£3,393**	**£1,720**	**£13,173**

Source: *Frontier Economics, based on the Study to Support the EU AI Act Impact Assessment.*

Note: ** To convert time estimates from minutes to GBP, we divide by 60 (to represent hours) and multiply by an hourly wage of £30.35.*
*** To convert additional staff estimates from FTE to GBP, we multiply by 1,820 (to represent working hours in a year) and multiply by an hourly wage of £30.35.*
**** To convert additional expenses from EUR to GBP, we multiply by an exchange rate of 0.89.*
***** To adjust the sum of compliance costs for preparedness, we multiply by a factor of 0.5.*

2. To calculate the cost from the **conformity assessment process**, we distinguish between firm sizes. The study supporting the EU impact assessment provides multiple estimates of conformity assessment costs. In particular, they provide one cost estimate for firms that would have to set up an entirely new conformity assessment process. This includes a time estimate of 150 hours to prepare the needed documents, as well as various fee estimates for audits and reviews by bodies responsible for certification. As with the HRS

[29] This is a small divergence from the study supporting the EU impact assessment, which uses the EU average wage rate for the Information and Communication sector.

[30] We use the 2020 annual average EUR/GBP exchange rate of 0.89 from the Bank of England.

requirements in the previous paragraph, we multiply the time estimate by the appropriate hourly wage and convert the fees provided in Euros to Pound using the appropriate exchange rate. They also provide a lower estimate for firms that already have similar processes installed due to requirements from other regulations (i.e., medical or manufacturing devices, etc). The study assumes that firms with prior processes installed would only require half of the time for document preparation (i.e., 75 hours) and could reduce some of the fees paid to certification bodies.

In our model, we apply the higher cost estimate for new conformity assessments for small and medium-sized firms, as we assume that they are less prepared for such requirements compared to large firms, to which we apply the lower costs estimate.[31] Table 10 summarises the conformity assessment cost in scenario 1.

Table 10 Compliance cost for HRS conformity assessment in scenario 1

	SME	Large
Time estimates in hours	150	75
Certification fees in EUR	€18,200	€14,400
Time estimate GBP*	£4,552	£2,276
Certification fees in GBP**	£16,182	£12,803
Sum of cost in GBP	**£20,734**	**£15,079**

Source: *Frontier Economics based on the Study to Support the EU AI Act Impact Assessment.*

Note: *The estimates for small and medium-sized firms are based on estimates for new conformity assessment procedures from the EU AI Act Impact Assessment. The estimates for large firms are based on the estimate for firms applying an existing conformity assessment procedure.*
** To convert time estimates from hours to GBP, we multiply by an hourly wage of £30.35.*
*** To convert certification fees from EUR to GBP, we multiply by an exchange rate of 0.89*

A.6.1.2 Transparency obligations for firms interacting with natural persons

The EU AI Act Impact Assessment only considers HRS firms and does not provide an estimate for obligations on firms interacting with natural persons. We apply a factor of 80% to the transparency requirement (i.e., information provision) under the HRS regulation, reflecting the assumption that the obligation for non-HRS firms is less burdensome.[32] [33]

Table 11 summarises the compliance cost per product in scenario 1.

[31] This reflects the views of stakeholders that SME firms are much less prepared for any AI regulation compared to large firms, which are already setting up such processes.

[32] The EU AI act only requires that "there should be an obligation to disclose that the content is generated through automated means." (EU AI Act).

[33] Assumption confirmed with the DCMS team.

Table 11 Compliance cost per product in scenario 1

	SME	Large
HRS firms	**£33,906**	**£28,252**
HRS requirements	£13,173	£13,173
Conformity assessment	£20,734	£15,079
Transparency for firms interacting with natural persons	**£2,751**	**£2,751**

Source: Frontier Economics based on the Study to Support the EU AI Act Impact Assessment.

A.6.2 Compliance cost per product in scenario 2

In scenario 2, firms are still defined as high-risk and subject to requirements, with the main difference that sector regulators identify which firms are categorised as such. Moreover, all firms are subject to minimal requirements, consisting of a "light-touch" conformity assessment procedure and transparency obligations. In the following section, we explain how we calculate estimates for these regulatory requirements in our model.

A.6.2.1 HRS firms

We assume that the **requirements for high-risk firms** in scenario 2 remain very similar to those in scenario 1, and thus use the same estimates for cost per product as in section A.6.2.1 of this annex. The HRS requirements are decreased by a factor of 50% to reflect industry preparedness, as was done for scenario 1.

As for scenario 1, we assume different **conformity assessment** cost amounts for different firm sizes. SMEs are assumed to set up a new, more costly process, whilst large firms are assumed to be more prepared and have a less costly process. We decrease the conformity assessment cost by 20% for each firm size to reflect the assumption that the conformity assessment procedure would be more "light-touch" in scenario 2 and would be coordinated by existing sector regulators rather than a central AI regulator.

A.6.2.2 Minimal requirements

Minimal requirements in scenario 2 consist of transparency obligations and "light" conformity assessments. These regulatory requirements exist in scenario 1, but we assume that they would be less stringent in scenario 2. We use the transparency and conformity costs estimates from scenario 1 but decrease them by certain factors. In particular, we assume that the cost of the minimal conformity assessment procedure would be 10% of the existing conformity assessment cost calculated in scenario 1, to reflect their ex-post nature in Scenario 2. Likewise, minimal transparency obligations are assumed to be 80% of the HRS transparency

obligations in scenario 1 given these are minimum requirements applying to all AI firms. We assume that these costs are similar for all firm sizes. [34]

Table 12 summarises the compliance cost per product for scenario 2 requirements and the factors applied to scenario 1 cost estimates.

Table 12 Compliance cost per product in scenario 2

Requirement	Reference Value from Scenario 1 Estimates		Decrease Factor for Scenario 2	Cost estimate for Scenario 2	
	SME	Large		SME	Large
HRS firms	**£33,906**	**£28,252**		**£29,759**	**£25,236**
HRS requirements	£13,173	£13,173	100%	13,173	13,173
HRS Conformity assessment	£20,734	£15,079	80%	£16,587	£12,063
Minimal requirements	**-**	**-**		**£2,884**	**£2,884**
Minimal conformity assessment	£15,079	£15,079	10%	£1,508	£1,508
Minimal transparency obligation	£1,720	£1,720	80%	£1,376	£1,376

Source: *Frontier Economics*

Note: *The "minimal conformity assessment" in scenario 1 represents the estimated cost for an existing conformity assessment procedure (for large firms). The "minimal transparency obligation" in scenario 1 represents the HRS information provision requirement.*

A.6.3 Familiarisation cost

All AI firms need to spend some time familiarising themselves with the new regulation for the first time. We assume that this applies to firms that fall under prohibition and those that would eventually exit the market.

We estimate the cost associated with the time spent reading through the regulatory text once, using the standard cost methodology in Governmental Commercial Function guidelines.[35] The report assumes that one page of regulation contains, on average, 300 words and that the average person reads 100 words per minute resulting in a reading speed of 3 minutes per page. Using the 108-page EU AI Act proposal as a reference, we thus estimate that a total of 324 minutes is needed to read through the AI regulation. We multiply this again with an hourly wage rate of £30.35 and find that to total cost of reading through the regulation would be £164 per unique product.

[34] The decrease factors applied to cost in these subsections were agreed on with the DCMS team.

[35] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/987615/SCM_Development_Guidance_V1_May_2021.pdf

A.6.4 Compliance cost per firm

Finally, we can compute the compliance cost per business by multiplying the compliance cost per product for each regulatory category and each firm size by the number of products per business for each firm size.[36] These are represented in Table 13 below.

Table 13 Compliance cost per firm in scenarios 1 and 2 in 2020

	Small	Medium	Large
Assumed number of products per firm	2	5	10
Scenario 1			
Compliance cost per product			
Total HRS compliance costs	£33,906	£33,906	£28,252
Transparency and disclaimers for AI interacting with a natural person (non-HRS systems)	£2,751	£2,751	£2,751
Compliance cost per firm			
Total HRS compliance costs	£67,812	£169,531	£282,517
Transparency and disclaimers for AI interacting with a natural person (non-HRS systems)	£5,503	£13,757	£27,514
Scenario 2			
Compliance cost per product			
Total HRS compliance	£29,759	£29,759	£25,236
Minimum requirements (non-HRS)	£2,884	£2,884	£2,884
Compliance cost per firm			
HRS firms	£59,519	£148,797	£252,359
Minimum requirements (non-HRS)	£5,767	£14,418	£28,836

Source: *Frontier Economics.*

Note: *In our model, we assume that regulation only starts in 2023. This table shows the cost per product and firm if the regulation were to start in 2020. As such, the costs for the first year of regulation would be higher, given the increase in the projected number of AI products from 2020 to 2023.*

Familiarisation costs for AI firms are excluded from the compliance costs analysis. The costs found in A.6.3 amount to £164 per unique product and are assumed to be a one-off cost at the start of the regulation period. Given that even for the large firms, this cost comes up to £1,640 (as shown in Table 13, we assume 10 unique products for large AI firms) which is comparatively small to the rest of the compliance costs. As such, this cost is excluded from the part of the model.

A.7 Compliance costs impact

This section describes how the model estimates the impact of compliance costs on market revenues. In particular, we explain the following impacts:

[36] See section A.3.2 for the calculation of products per business.

1. Compliance cost pass-through to consumers
2. AI firms exiting (or not entering) the market due to high compliance cost
3. Consumer purchasing less due to cost pass-through
4. AI firms investing less in R&D due to compliance costs

A.7.1 Cost Pass-through

Assessing how much cost businesses can pass through to consumers requires complex analysis that is not in this project's scope.[37] For simplicity, we assume that each business can pass through 50% of its compliance cost to consumers. Literature on the topic suggested suggests that this assumption is in the feasible range.[38] We thus multiply the compliance cost per business by the remaining 50% to reflect the amount of compliance cost a business still considers in its decision-making process. This is represented in Table 14 below.

Table 14 Compliance cost per firm in scenarios 1 and 2 after cost pass-through, in 2020

	Small	Medium	Large
Scenario 1			
Compliance cost per firm			
HRS firms	£33,906	£84,766	£141,258
Firms interacting with natural persons	£2,751	£6,878	£13,757
Scenario 2			
Compliance cost per firm			
HRS firms	£29,759	£74,399	£126,179
Firms with minimal requirements	£2,884	£7,209	£14,418

Source: *Frontier Economics*

Note: *In our model, we assume that regulation only starts in 2023. This table shows the cost per product and firm if regulation were to start in 2020. As such, the costs for the first year of regulation would be higher, given the increase in the projected number of AI products from 2020 to 2023*

A.7.2 Exiting the Market Due to Regulation

In scenario 1 of our model, we assume that firms subject to HRS regulation consider exiting the market, depending on their profitability. We do not consider firms interacting with a natural person to have the same decision given the costs are low and would probably not have that

[37] See section 6.1.3.b.a of the main report for the discussion about costs pass-through.

[38] The RBB report: "Cost pass-through: theory, measurement, and potential policy implications" (RBB, 2014) includes a literature review - available at the time - about the ability to pass through costs. The estimates are volatile, and the assumption of 50% is in the reported range. We were not able to locate further current indications of what would be a relevant cost pass-through, and as such, we agreed on this assumption with the DCMS team.

impact on those firms. In scenario 2, we assume that all firms consider this process, as all firms are also subject to minimal requirements.

To calculate how many firms drop out due to high compliance costs, and the associated lost revenues, we take the following steps for each scenario:

1. We calculate the **total cost of compliance per firm size**. In scenario 1, we only consider costs from compliance with HRS requirements to impact businesses' decision to stay or leave the market. For scenario 2, we consider costs both from compliance with HRS requirements and minimal requirements to impact this decision. Section A.6 in the annex explains the calculations for the total compliance cost per firm for each regulatory category. We assume that the decision about staying or leaving the market is based on the compliance costs each AI firm faces after they have assessed the amount that would be passed through. As explained above, we assume that they would be able to pass 50% of the compliance costs to consumers and thus face only the remaining 50% of compliance costs.

2. We calculate the **revenue threshold below which a firm would exit (or not enter) the market**. We assume that a firm exits the market if the total compliance cost it faces (as presented in Table 14 above) is higher than 10% of its total revenues.[39] This revenue threshold can be represented by the following equation:

$$Minimum\ revenue\ threshold = \frac{Total\ compliance\ cost\ per\ firm}{Compliance\ cost/Revenue\ ratio}$$

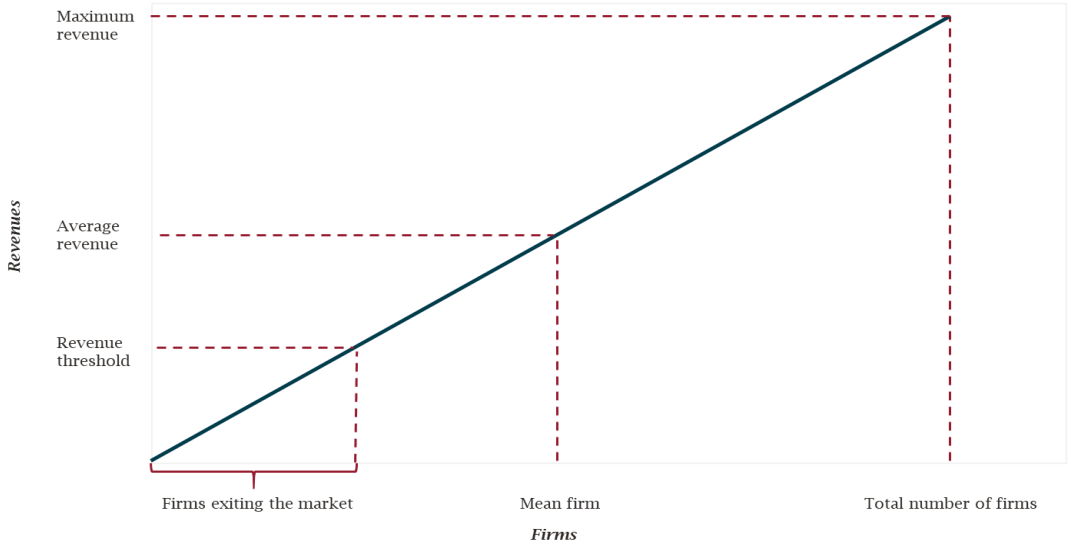
   Given that we have previously calculated the total compliance cost per firm, we can solve for the minimum revenue a firm has to generate to stay in the market. We do this for each firm size individually.

3. We calculate **the number of firms that exit the market**. First, we assume that revenues are uniformly distributed within each firm size category.[40] Figure 2 shows an illustration of the cumulative distribution function (CDF) for firm revenues based on this assumption.

[39] This is based on the assumption that before regulation, AI developing firms have on average a profit margin of 10%. AI firms would exit (or not enter) the market if the compliance costs they are faced with would make them unprofitable (i.e., if the compliance cost to revenue ratio exceeds 10%). We base the assumption on ONS data suggesting a 10% profit margin in the non-financial sector (ONS, Profitability of UK companies – rates of return and revisions. Available at: https://www.ons.gov.uk/economy/nationalaccounts/uksectoraccounts/datasets/profitabilityofukcompaniesreferencetable) .

[40] This is a simplifying assumption, which allows us to compute the number of firms leaving. In reality, it is more likely that firms follow a normal distribution highly skewed to the lower side (i.e., a lot of firms with lower revenues and a small number of firms with high revenues).

Figure 2 Illustration of the cumulative distriution function of AI firm revenues



Source: *Frontier Economics*
Note: *Assuming a uniform distribution*

To find the number of firms exiting the market in each scenario, we need to solve the following equation:

$$Number\ of\ existing\ firms = \frac{Revenue\ threshold}{Slope\ of\ the\ CDF}$$

The slope of the cumulative distribution function can be found using the following equation:

$$Slope\ of\ the\ CDF = \frac{Average\ revenue\ per\ firm}{Mean\ firm}$$

We compute the average revenue per firm (for each size category separately) by dividing the total baseline revenues by the total number of firms in that size category. Moreover, the mean number of firms is calculated by dividing the total number of firms by two due to the assumption of uniformly distributed revenue. Given that we only consider HRS firms in scenario 1, we compute the mean HRS firm by multiplying the mean number of firms by the share of HRS firms in scenario 1. In scenario 2, we follow the same step twice, once for HRS firms and once for firms with minimal requirements.

Using the revenue threshold calculated in the previous step, we compute the number of HRS firms (and non-HRS firms in scenario 2) exiting the market. We calculate this for each firm size and each year.

4. Finally, we compute the foregone revenues associated with AI firms exiting (or not entering) the market. The revenues associated with the firms exiting (or not entering) the market are represented by the area under the CDF chart in Figure 2. Given the assumption of uniform distribution, we can compute the foregone revenues by multiplying the number of firms exiting the market by the revenue threshold and dividing by 2 (the triangle area under the chart). This is done for each firm size and each year. In scenario 2, we follow the calculation steps twice, once for firms with HRS requirements and firms with minimal requirements.

A.7.3 Adjusted consumer spending

In this section, we explain how to compute the impacts on market revenues from adjusted consumer spending. We go through the following steps for each scenario.

1. We calculate the **total compliance cost for each regulatory requirement**. First, we calculate the number of firms for each regulatory category that decided to stay (or enter) the AI market and now face the compliance costs. In scenario 1, we subtract the number of HRS firms exiting (or not entering) calculated above from the total number of HRS firms. For scenario 2, we subtract the number of HRS firms exiting (or not entering) from the total HRS firms, and the number of firms with minimal requirements exiting (or not entering) from the total number of firms with minimal requirements. We then multiply the number of remaining firms in each regulatory category by the total compliance cost per firm, calculated in section A.6. This is done for each firm size each year.

2. We calculate the **amount of compliance cost passed to consumers for each regulatory requirement**. As explained in section A.6, we assume that 50% of the compliance cost is passed through to consumers in the form of a price increase. Hence, we multiply the total compliance cost from the remaining firms calculated in the previous step by 50% for each regulatory category.

Finally, we calculate the **total amount by which consumers adjust/reduce their spending on AI products**. As explained in section 6.1.3.b.a of the main report, we do not model price sensitivities for AI products in the scope of this report. For simplicity, we assume that a £1 increase in prices leads to a £0.5 decrease in expenditures.[41] We, therefore, calculate the sum of all costs passed on from regulatory requirements and multiply it by 50% to find the reduced revenues due to adjusted consumer spending. This is done for each firm size and each year.

[41] Depending on the actual prices and quantity of AI products in the market, the way we model the impact of compliance cost pass-through to consumers and the final impacts on AI revenues, implies an elasticity of ca. -0.7 where: 0 would be perfect inelasticity (no consumption change give price increase) and -1 unitary elasticity (1% price increase leads to 1% consumption decrease).

A.7.4 R&D reduction

In this section, we explain how we compute the impacts on market revenues from reducing internal R&D investments. We go through the following steps:

1. We calculate t**he amount of compliance cost not passed on to consumers but faced by the firms**. We follow the same first two steps as in A.7.3 of the annex. As we assume a pass-through rate of 50%, the same amount of cost is faced by the firm.

2. We calculate **the amount of cost that is deducted from R&D investments to reduce compliance costs**. Stakeholders we spoke to indicate that some (or the majority) of the compliance costs would be deducted from internal development investments. For simplicity, we assume that half of the remaining compliance cost (after the partial pass-through to consumers) is deducted from internal R&D investments and therefore multiply the remainder of the costs estimated in the previous step by 50%.

3. **We calculate the reduced market revenues due to lower internal investment levels in R&D.** We assume that R&D investments in one year lead to returns in the next year. However, we do not have a source of information about the internal levels of R&D investment in the market. Instead, we use the ROI from VC investments, calculated in section A.3.4 of this annex, as a proxy for internal ROI. To compute the foregone revenues from investing less in a given year, we multiply the reduced R&D investments of the previous year (calculated in the previous step) with the ROI of the current year. This is represented by the formula below.

$$\Delta\, Revenues^{R\&D}{}_{y} = \Delta Investments^{R\&D}{}_{y-1} \times ROI^{VC}{}_{y}$$

A.8 Consumer trust

This section describes how the model estimates changes in consumer trust and its impact on the level of data sharing and the level of AI purchases. This annex provides explanations for:

1. modelling trust changes;

2. modelling how changes in trust impact data sharing and productivity; and

3. modelling how changes in trust impact AI purchases.

For each, we explain the methodology, sources and assumptions that were made

A.8.1 Modelling of trust changes

Our model of changes in trust due to AI regulation is based solely on conversations with experts and limited insights from stakeholder interviews. We acknowledge that further research and insights into how consumers' trust will change due to regulation should be

conducted to better inform the results of our analysis. The results of this analysis should be treated as an indication of the potential impact on consumers' trust rather than projections or estimations.

The methodology is based on modelling the change in the level of trust on a Likert scale (where 1 is low trust and 5 is high trust) under each scenario. We estimate the following:

1. **Change in trust from each regulatory aspect** (e.g., the fact that there is now a prohibited list of AI products). Due to limited research in this field, those estimations are based solely on conversations with stakeholders, AI experts and the Centre for Data Ethics and Innovation (CDEI). They are presented in Table 15 below, together with the information we collected, which helped inform those assessments. Please note that trust impacts presented below are used as a weighted average and applied to a baseline trust level of 3 on the Likert scale (discussed in the next step).

Table 15 Changes in trust levels on the Likert Scale due to the presence of each regulatory aspect

Aspects of regulation	# points trust change	Scenario applies to	Comments (out of Likert scale)
HRS Conformity assessment (ex-ante)	0.00	Scenario 1	Based on conversations with an AI expert and the views of stakeholders. Having conformity assessments for HRS might have an even more limited impact (compared to the impact of prohibition) on consumers' trust, mainly as the majority of the population would not be aware of the regulation. We assume no impact.
Transparency requirements for non-HRS that interact with a natural person	0.50	Scenario 1	Both experts agree that transparency requirements would have the most impact on consumers' trust. For scenario 1, this might be slightly limited as the perception was that businesses would deal with these requirements as a 'tick-box' exercise.
Voluntary codes of conduct	0.00	Scenario 1	Based on stakeholders' views and collaboration by an expert view, only businesses that already do internal processes to identify risk would engage with this. As such, no further impact on trust.
HRS Conformity assessment (ex-post)	0.00	Scenario 2	Based on conversations with an AI expert and the views of stakeholders. Having conformity assessments for HRS might have an even more limited impact (compared to the impact of prohibition) on consumers' trust, mainly as the majority of the population would not be aware of the regulation. We assume no impact.
Transparency requirements for all (minimal)	0.50	Scenario 2	Both experts agree that transparency requirements would have the most impact on consumers' trust. For scenario 1, this might be slightly limited as the perception was that business would deal with these requirements as a 'tick-box' exercise. For scenario 2, if the outline of the transparency is more about explaining the processes and having accountability for the results, then this should be higher than 1. We assume a simpler transparency requirement.
Self-conformity assessment for all (minimal)	0.25	Scenario 2	Based on conversations with an AI expert, having a self-assessment that is results-based should result in high trust for consumers as accountability and transparency would be visible to them. We assume only a half-point chance to be conservative as we also heard that conformity requirements usually do not impact trust as much as transparency.
Prohibition	0.25	Both scenarios 1 and 2	Based on conversations with an AI expert and the views of stakeholders. Prohibition is expected to have a limited impact on consumers' trust, mainly as the majority of the population would not be aware of the regulation and the prohibition list.

HRS Identification and public list	0.00	Both scenarios 1 and 2	Based on conversations with an AI expert and the views of stakeholders. HRS identification is expected to have an even more limited impact (compared to the impact of prohibition) on consumers' trust, mainly as the majority of the population would not be aware of the regulation and the HRS list. We assume no impact.
HRS Transparency requirements	0.50	Both scenarios 1 and 2	Both experts agree that transparency requirements would have the most tangible impact on consumers' trust. For scenario 1, this might be slightly limited as the perception was that businesses would deal with those requirements as a 'tick-box' exercise.

Source: *Frontier Economics*

Note: *Changes in the trust levels are averaged for each scenario. See further explanations below.*

2. **The proportion of consumers in the market who would be affected by the specific aspect of regulation.**

   We assume that the trust level would impact only those consumers that interact with the relevant regulatory aspect. For instance, transparency requirements for HRS under scenario 1, would only be seen by consumers that interact with these products in the market, and only the trust levels of those consumers would change. Since we do not have available information about the proportion of consumers that would interact with each AI aspect, we proxy this assumption by using the assumed proportion of the market that would fall under each regulatory category in the market. For example, the proportion of consumers that would adjust their trust due to HRS requirements is assumed to be 8% in scenario 1, reflecting the proportion of HRS products in the sector for that scenario.[42] We acknowledge that the proportion of consumers interacting with HRS can be higher or lower in reality.

3. Using the percentage of the population that is affected by each regulatory aspect and the anticipated level of change, we calculated the weighted average trust change for each scenario.

Table 16 Weighted trust changes per scenario and regulatory aspect

Aspect of regulation	# points trust change	% of the AI market impacted
Scenario 1		
Prohibition	0.25	100%*
HRS Identification and public list	0.00	8%
HRS Transparency requirements	0.50	8%
HRS Conformity assessment (ex-ante)	0.00	8%
Transparency requirements for non-HRS that interact with a natural person	0.50	39%
Voluntary codes of conduct	0.00	100%
The average change in trust level	**0.08**	
Scenario 2		
Prohibition	0.25	100%*
HRS Identification and public list	0.00	4%
HRS Transparency requirements	0.50	4%
HRS Conformity assessment (ex-post)	0.00	4%

[42] See sections A.4 for further details about the calculation for shares of firms that fall under each regulatory category for each scenario.

Transparency requirements for all (minimal)	0.50	100%
The average change in trust level	**0.13**	

Source: *Frontier Economics*

Note: *For details about the shares of firms that fall under each regulatory category, see section A.4. *Prohibition is assumed to impact the full market, given that consumers would assume that harmful products have been removed, increasing the trust across the total AI market*

A.8.2 Modelling of trust changes impact on data sharing and productivity

Using the estimated average change in consumer trust, we model the change in the level of data shared with AI products and the subsequent increase in productivity. The modelling follows the following steps:

a. Change in consumers' trust impacts the level of data sharing with AI products.

The Economic Impact of Trust in Data Ecosystems report (Frontier Economics report for the ODI, 2021)[43] estimated in the medium scenario that a one-point change in trust on a Likert scale would lead to a 0.27 points change (in the same direction) in data sharing levels. Following the assumptions in the internal analysis conducted for the DCMS by Frontier Economics which assessed the impact of data protection on productivity, we assume a baseline trust level of 4 on a Likert scale, leading to a change of 6.75% in the level of data sharing (0.27/4 = 0.0675). Applying the weighted average change in consumer trust calculated above, we arrive at the weighted average % change in data sharing scores. This leads to a 0.55% (0.08X0.065= 0.00546) increase in data sharing level for scenario 1 and a (0.13X0.0675=0.00866) 0.87% increase for scenario 2.

b. Data sharing level impact on productivity

Nesta (2014) estimated that a change of one point on the Likert scale in data sharing changes productivity by 8%.[44] The paper studies 21 different data-related factors that can improve firms' productivity. Two of those are related to data collection, which we assume to be the only ones affected by the increased trust from the new AI regulation.

To account for that, we adjust the percentage changes calculated in the step above. In particular, we assume that all 21 data factors start at a baseline of 3 on the Likert scale. Only the two relevant factors increase by the percentages calculated above. Finally, we calculate the weighted average across the 21 factors. That results in 0.035% (0.55% X(2/21)) for scenario 1 and 0.056% (0.87%X(2/21)) for scenario 2.

[43] "Economic Impact of Trust in Data Ecosystems", Frontier Economics report for the Open Data Institute (ODI), 2021). Available at: http://theodi.org/wp-content/uploads/2021/03/RPT_Trust-in-data-ecosystems-23.02.21-STC-final-report.pdf

[44] "The analytical firm: Estimating the effect of data and online analytics on firm performance", Nesta, 2014. Available at: https://media.nesta.org.uk/documents/1405_the_analytical_firm_-_final.pdf

Those percentages are then applied to AI revenues after phase 1 (business decision) to arrive at the change in the AI revenues due to an increase in the level of data sharing.

A.8.3 Modelling the impact of changes in trust on AI purchases

Using the estimated average change in consumer trust from section A.8.1, we model the change in the level of AI purchases. The modelling is based on Qalati (2021)[45], which among other things, explores how risk perception affects intention for online shopping and includes the following steps:

1. **Changes in perceived risk:**

The paper includes five aspects of risk; financial risk, product risk, security risk, time risk, and social risk. We believe that only two would be impacted by increased trust due to AI regulations - social risk and security risk - since the regulation aims to reduce social harms (such as discrimination) and increase security in AI usage.

We assume a baseline risk perception of 3 on the Likert scale for all five risk aspects.[46] In the case of risk, a 1 represents a high-risk perception level, and a 5 represents a low-risk perception level. As such, an increase on the Likert scale, in this case, represents a decrease in risk. We assume that trust is negatively correlated with the perceived risk and apply the average increase in trust levels found in section A.8.2 estimated above to the baseline perceived risk levels to the two risk factors identified as relevant.

The paper provides regression coefficient estimations of the impact of the five risks on overall perceived risk. The paper, however, does not explain if cross interaction between the risks was considered. To avoid overestimation, we weigh the impact of the increase in trust on the two risks across all 5 risk measures. Table 17 below presents our calculations and shows that for scenario 1 the overall change in perceived risk is 0.03, and for scenario two it is 0.07.

Table 17 Coefficients, baseline risk scales and new risk weighted total – perceived risk for both scenarios

Item	Coefficient	Baseline	New scale - scenario 1	New scale - scenario 2
Financial risk	0.881	3.00	3.00	3.00
Product risk	0.899	3.00	3.00	3.00

[45] Sikandar Ali Qalati, Esthela Galvan Vela, Wenyuan Li, Sarfraz Ahmed Dakhan, Truong Thi Hong Thuy & Sajid Hussain Merani | (2021) Effects of perceived service quality, website quality, and reputation on purchase intention: The mediating and moderating roles of trust and perceived risk in online shopping, Cogent Business & Management, 8:1, 1869363, DOI: 10.1080/23311975.2020.1869363. Available at: https://www.tandfonline.com/doi/pdf/10.1080/23311975.2020.1869363?needAccess=true

[46] For risk perception, the higher the score the lower the risk perception.

Security risk	**0.935**	**3.00**	**3.08**	**3.16**
Time risk	0.896	3.00	3.00	3.00
Social risk	**0.892**	**3.00**	**3.08**	**3.16**
Sum/sum-product between scale and coefficient	**4.503**	**13.51**	**13.66**	**13.80**
Perceived risk		**Baseline**	**New - scenario 1**	**New - scenario 2**
Change in perceived risk		3.00	3.03	3.07

Source: Frontier Economics

Note: The total change in perceived risk weighs the changes in the two relevant factors by the coefficients to avoid an overestimation

This change in the perceived risk in each scenario interacts with the 11.7% increase in purchasing intention for a 1 point change in perceived risk estimated in the paper. For scenario 1 this is a 0.38% increase in the purchasing intention and (0.0328X0.117=0.0038) and a 0.81% for scenario 2 (0.0698X0.117=0.00816). These percentages are then interacted with the phase 1 AI revenues for each scenario.

We note that this methodology has various limitations (explored below), but our view is that the model yields a good sense of the order of magnitude of likely changes in purchasing intentions and, subsequently, changes in AI revenues driven by a change in consumer trust. One assumption we rely on is that perceived risk and trust levels are similar. Although the two are not the same, one can argue that trust and risk perception are the inverse of each other - if one perceives less risk from something, one will trust it more and vice versa. Second, we assume that the intention to shop online has the same risk sensitivity as purchases of AI products – an assumption that can be debated. Lastly, the paper was not yet peer-reviewed, and the analysis was based on data collected from an online panel in Pakistan. This may mean that the results of the paper might be inaccurate and may not apply to the UK market. We decided to include this part of the model even with those limitations in mind since we believe that this is an important aspect of the AI regulation, which may bear significant implications for regulatory decisions. To estimate this impact more accurately, we would advise conducting similar research to that in Qalati (2021)[47] in the UK, revising the econometric approach in the paper and focusing on AI purchasing rather than on online shopping.

A.9 Market uncertainty

This section describes how we estimate the change in market uncertainty and its impact on investments and the level of AI revenues. We base this part of the model on Dejuan-Bitri (2021), which studies the impact that changes in market uncertainty can have on levels of private investment.[48] The paper uses the Economic Policy Uncertainty index (EPU) as a proxy for market uncertainty and looks at how changes in the EPU index affect the investment rate.

This annex provides explanations for:

[47] https://www.tandfonline.com/doi/pdf/10.1080/23311975.2020.1869363?needAccess=true

[48] Dejuan-Bitria, D., Ghirelli, C. Economic policy uncertainty and investment in Spain. SERIEs 12, 351–388 (2021). Available at: https://doi.org/10.1007/s13209-021-00237-5

1. modelling uncertainty changes;
2. modelling changes in VC investment; and
3. modelling how changes in VC investment impact AI revenues.

For each, we explain the methodology, sources and assumptions that were made.

A.9.1 Modelling of uncertainty changes

To model the change in market uncertainty, we follow Dejuan-Bitri (2021) and utilise the Economic Policy Uncertainty index (EPU) for the UK.[49] We look at the historical changes in the EPU index for three relevant events in the past to assess what could plausibly be considered a reasonable change in the index from the introduction of AI regulation under each scenario. Table 18 below shows the EPU changes in the month of each event and the assumed EPU change chosen for each scenario.

Table 18 EPU changes in the month of three relevant events and the chosen EPU changes for the two scenarios

Policy event	Monthly EPU change
Brexit referendum	2.57
Covid-19 pandemic outbreak	1.42
Introduction of GDPR	0.19
Model assumptions:	
Scenario 1	0.19
Scenario 2	0.10

Source: Frontier Economics based on the information from the EPU website
Note: Available at https://www.policyuncertainty.com/uk_monthly.html

We assume a change of 0.19 on the EPU index for scenario 1, reflecting our assumption that the market uncertainty reaction to AI regulation would be similar to the change in the index around the introduction of the GDPR. For scenario 2, we assume that since it would be sectoral regulation and would not introduce a new AI regulator, it would be clearer, leading to lower uncertainty in the market. Further research into those assumptions would be valuable. For example, a wider business survey may reveal if businesses anticipate the same impact as after the introduction of GDPR and whether they believe that sectoral regulation would lead to less uncertainty in the market. Our stakeholder interactions suggested this would be the case.

A.9.2 Modelling changes in VC investment

To utilise the estimate in Dejuan-Bitri (2021), aside from the anticipated EPU changes, we also need to have information about the investment rate, which the paper defines as the sum

[49] https://www.policyuncertainty.com/uk_monthly.html

of gross fixed tangible and intangible capital formation divided by the total capital stock. We use baseline VC investment and AI revenues to arrive at the two needed statistics, which would allow the calculation of the investment rate in the model:

1. Adjusting VC investment to model gross fixed tangible and intangible capital:

VC investments are only one form of several funding options available for SME AI firms. Their total funding can be (in a simplified world) assumed to be the same as the gross fixed tangible and intangible capital.[50] To adjust SME VC investment and arrive at the gross fixed tangible and intangible capital, we do the following:

- **Add governmental investments:** We could not find annual reporting on the UK government's level invested in AI. It was mentioned that since 2014 the UK government had invested about £2.3 billion in the AI market.[51] It is hard to say how much that would have been per year, but we are assuming investment levels increase over the years (i.e., assuming higher investment levels in later years). We assume that about £800,000 were invested in the AI market in 2020 and add this amount to VC investment to account for governmental investments.[52] For ease of further calculation, £800,000 addition is equal to applying a factor of 1.8 on the 2020 VC investment level. From here on, we call this governmental investment factor. If information about annual governmental investment can be obtained, the model can change the assumption.
- **Add firms' debt:** We could not find estimates about the debt level of AI SME firms compared to investments. We use a proxy and inflate the private and governmental investment estimated above by tech companies' debt-to-equity ratio. Using the average published debt to equity ratio for Q1 2022 as published on 31.03.22 is 0.33 (i.e., for every £1 of equity tech firms have, they have £0.33 of debt).[53]

These two steps follow this formula:

$$Proxy\ capital = VC\ investments\ X\ Governmental\ investment\ factor\ X\ Debt\ to\ equity\ ratio$$

These two adjustments result in a proxy for the total funding of SME AI firms used as the numerator when calculating investment rate (i.e., as a proxy for gross fixed tangible and intangible capital).

[50] Assuming that all the funding is spent in that year.

[51] https://www.gov.uk/government/news/new-ten-year-plan-to-make-britain-a-global-ai-superpower#:~:text=The%20government%20has%20invested%20more,Intelligence%20in%20health%20and%20care

[52] Further investigation into this by the DCMS team can help identify a better figure for this assumption.

[53] https://csimarket.com/Industry/industry_Financial_Strength_Ratios.php?s=1000.May%20change. The number maybe be changed in the source.

2. **Adjusting SME AI revenues to model the total capital stock:** We use the annual SME AI revenues and apply the Price-to-Sale ratio, which is defined as "a number that is helpful for recognising a company's total value and comparing it to the actual revenue being generated by that business."[54] We use the estimated Price-to-Sales statistic for the technology sector for Q4 2021, which was 6.7.[55]

   This step follows this formula:

$$Proxy\ stock\ capital\ = AI\ revenues\ X\ Price\ to\ Sales$$

   We take the two proxies from the adjustments above, and by dividing the first by the second, we get to a proxy for the investment rate for AI SMEs in the UK every year. This step follows the following formula:

$$Proxy\ investment\ rate\ = \frac{Total\ funding}{Proxy\ stock\ capital} =$$
$$= \frac{VC\ investments\ X\ Governmental\ investment\ factor\ X\ Debt\ to\ equity\ ratio}{AI\ revenues\ X\ Price\ to\ Sales}$$

The next step is to estimate how the investment rate in the baseline changes with trust changes. We first interact the change in the EPU uncertainty level found in section A.9.1 above for each scenario with the estimated change in the investment rate found in Dejuan-Bitri (2021). A change of 1 in the EPU index was found to decrease the investment rate by 0.046 percentage points. For scenario 1 that means a reduction of 0.89% (0.046X0.1926= 0.00885) and for scenario 2 a reduction of 0.44% (0.046X0.0963=0.00442). We note that this paper is based on firms in Spain. As such, the estimations of the reduction in investment rates may not be fully applicable to the UK.

We deduct the changes found above from the baseline investment rates that we have found for the years that regulatory uncertainty is expected to last – we assumed that to be two years 2023 and 2024. To arrive at this assumption, we looked at how long uncertainty lingered after other regulatory events such as Brexit and the introduction of GDPR. For Brexit, some sources suggest that uncertainty lingered for about two years.[56] Other sources suggest that uncertainty after the Brexit referendum continued for at least five years.[57] A study looking at the impact of the GDPR on VC investment after 1.5 years showed that European companies were still receiving less investment than their US counterparts.[58] To be conservative, we assume that

[54] https://companiesmarketcap.com/lexicon/price-to-sales-ratio-definition/

[55] https://csimarket.com/Industry/industry_valuation_ttm.php?ps&s=1000

[56] https://blogs.lse.ac.uk/brexit/2019/09/11/the-impact-of-brexit-on-uk-firms-reduced-investments-and-decreased-productivity/. Figure1.

[57] https://www.bankofengland.co.uk/quarterly-bulletin/2021/2021-q2/influences-on-investment-by-uk-businesses-evidence-from-the-decision-maker-panel

[58] https://voxeu.org/article/short-run-effects-gdpr-technology-venture-investment

uncertainty under both scenarios would linger for two years after the introduction of AI regulation from 2023 to 2024 (inclusive).

We then proceed with calculating the new level of investment each year. We use AI revenues in phase 1 for each of those two years and the new investment rate. Rearranging the equation from above, we arrive at the following calculation for the new investment level:

$$New\ VC\ investment\ = \frac{New\ investment\ rate\ X\ AI\ revenues\ X\ Price\ to\ Sales\ X}{Governmental\ investment\ factor\ X\ Debt\ to\ equity\ ratio}$$

A.9.3 Modelling the impact of VC investments on AI revenues

The new VC investment now interacts with the ROI found in section A.3.4 (assuming that the ROI is stable between baseline and the two scenarios) of the following year (investment produce revenues only in the future). Rearranging the ROI formula, we get the following calculation for new AI revenues:

$$New\ AI\ revenue_t\ = \frac{ROI_t\ X\ New\ VC\ investment_{t-1}}{profit\ margin}$$

A.10 Governmental regulatory costs

This section describes how we model the costs that the government would incur from the need to uphold the AI regulation. Each of the two scenarios has different regulatory approaches, and we explain each separately below.

A.10.1 Governmental regulatory costs in scenario 1

Under this scenario, the government creates a new central regulatory body. We model two costs associated with this body:

1. **Ongoing costs from operating the central regulator:**

   We first estimate the initial number of employees needed for the central regulatory body. We assessed 9 UK regulators for which we identified data regarding the number of employees they have. Those are presented in Table 19 below alongside total annual expenditure and estimated cost per employee (by dividing the total cost by the number of employees).

Table 19 Number of employees, annual expenditure and cost per employee for selected regulatory bodies in the UK

Regulator	Number of employees in 2017	Annual expenditure in 2017 (£ million)	Average per employee
FCA	3,363	£509.00	£151,353
Ofgem	971	£86.00	£88,568
Ofcom	828	£139.00	£167,874
CAA	927	£130.00	£140,237
ORR	303	£31.00	£102,310
CMA	589	£139.00	£235,993
HSE	2,549	£224.00	£87,878
FSA	1,526	£131.00	£85,845
Ofwat	161	£22.00	£136,646

Source: Frontier Economics based on https://www.nao.org.uk/wp-content/uploads/2017/09/A-Short-Guide-to-Regulation.pdf

Given the data provided, it would be reasonable to assume that 500 employees are needed for the central regulator. The number of employees in the initial year is then increased with the growth rate of the AI revenues modelled at the end of scenario 1 (i.e., end of phase 2 revenues) to reflect the fact that more employees would be needed given that there are more AI products in the market.

We then estimate the cost per employee based on the average cost per employee calculated in Table 19 above. The weighted average of those costs is £125,791. We believe that this might be slightly higher than what could be the average costs and take the midpoint between this weighted average and the minimum cost per employee calculated in the table to arrive at £105,818 per annum per employee. Although this may sound like a high estimation, note that those are total costs per employee and not annual wage per employee. Details about what is included in the annual expenditure in those reports were not given, but we assume that those would include other expenses, such as electricity, which would provide a better estimation of the total costs for the regulatory body compared to only using annual wages. Those costs per employee are kept stable over the years.

Having both the number of employees and the cost per employee, we calculate the total annual ongoing costs for the central regulatory body.

2. The initial one-off investment cost in the central regulatory body:

Given internal indication from the DCMS team, we assume that the initial investment in the central regulatory body would be half that of the operational costs in the first year of regulation. Since the first year of regulation is 2023, the estimated number of employees in that year is 729. Assuming £105,181 cost per employee amounts to total operational costs for the year to £77,093,910, half of which would be £38,546,955 attributed to initial investment costs.

A.10.2 Governmental regulatory costs in scenario 2

Under scenario 2 we assume that current UK regulators will be tasked with upholding the regulation. As such, we calculate the additional employees required across regulators to fulfil the additional responsibility and the cost associated with their employment.

We first identify the number of regulators that would need to undertake the additional AI regulation responsibility. We identified 61 such bodies. The full list of UK regulatory bodies and a flag for those that we have assumed would have to add employees to fulfil the AI regulation responsibilities is presented below in Table 20.

Table 20 List of AI regulations and a flag for those assumed to need additional employees to fulfil AI regulation responsibilities

Regulatory bodies
Charity Commission for England and Wales
Charity Commission for Northern Ireland
Office of the Scottish Charity Regulator
The General Teaching Councils for Scotland, Wales and Northern Ireland
Ofqual – Office of Qualifications and Examinations Regulation
Ofsted – Office for Standards in Education, Children's Services and Skills
Office for Students (OfS)
Environment Agency (EA)
Marine Management Organisation (MMO)
Natural Resources Wales (NRW)
Northern Ireland Environment Agency (NIEA)
Scottish Environment Protection Agency (SEPA)
Financial Conduct Authority (FCA)
Financial Reporting Council
Institute of Chartered Accountants in England and Wales
Office of the Regulator of Community Interest Companies (ORCIC)
Pensions Regulator
Prudential Regulation Authority (PRA)
The Office for Professional Body Anti-Money Laundering Supervision (OPBAS)
Care Quality Commission (CQC)
Complementary and Natural Healthcare Council (CNHC)
General Chiropractic Council (GCC)
General Dental Council (GDC)
General Medical Council (GMC)
General Optical Council (GOC)
General Osteopathic Council (GOsC)
General Pharmaceutical Council (GPhC)
Health and Safety Executive
Healthcare Inspectorate Wales (HIW)
Human Fertilisation and Embryology Authority
Medicines and Healthcare products Regulatory Agency (MHRA)
NHS Improvement (NHSI)
Nursing and Midwifery Council (NMC)

Pharmaceutical Society of Northern Ireland (PSNI)	1
Professional Standards Authority for Health and Social Care	1
Royal College of Veterinary Surgeons (RCVS)	1
UK Health Security Agency (UKHSA)	1
Regulator of Social Housing	1
Scottish Housing Regulator	1
Authorised Conveyancing Practitioners Board	
Bar Standards Board	1
CILEx Regulation	
Faculty of Advocates	
Law Society of Northern Ireland	
Law Society of Scotland	
Master of the Faculties	
Office of the Immigration Services Commissioner	1
Solicitors Regulation Authority	1
Council for Licensed Conveyancers	1
Scottish Care Inspectorate	1
Care Council for Wales (CCW)	1
Northern Ireland Social Care Council (NISCC)	1
Scottish Social Services Council (SSSC)	1
Civil Aviation Authority (CAA)	1
Office of Rail and Road (ORR)	1
Ofcom – independent regulator and competition authority for the UK communications industries	1
Office for Nuclear Regulation (ONR)	1
Ofgem – the Office of the Gas and Electricity Markets	1
Ofwat – the Water Services Regulation Authority	1
Water Industry Commissioner for Scotland	1
Accreditation Service	1
Advertising Standards Authority	1
British Board of Film Classification	
Chartered Institute for the Management of Sport and Physical Activity	1
Competition and Markets Authority	1
Council for Registered Gas Installers	
Engineering Council – the regulatory body for the engineering profession	1
Equality and Human Rights Commission	1
Food Standards Agency	1
Forensic Science Regulator	1
Fundraising Regulator	1
Gambling Commission	1
Gaming Board for Great Britain	
Gangmasters and Labour Abuse Authority	
HM Revenue and Customs	1
IMPRESS	
Independent Press Standards Organisation	
Information Commissioner's Office	1
Oil and Gas Authority	1
Planning Inspectorate	1
Independent Office for Police Conduct	1
Security Industry Authority	1

Source: Frontier Economics

Note: Relevance flag provided by the DCMS team.

In the absence of data on the number of employees for each regulator listed, using the number of employees for the nine regulatory bodies presented in Table 20 above, we assume that there would be about 500 employees on average for each regulator.[59] Multiplying 500 employees by the 61 relevant regulatory bodies, we arrive at an estimate of the total number of existing employees across the relevant regulators - of 30,500.

We further assume that the new responsibility would need a 1.5% uplift in the number of employees across the relevant regulators leading to an additional workforce of 458 employees. This number is reasonable as it is slightly below the number of employees required for the central coordinating body calculated for scenario 1. We assume that the overall number of additional employees needed for undertaking regulatory work should be similar, with a slight advantage for scenario 2.[60]

As in the calculation for operational costs in scenario 1, we inflate the number of additional employees needed by the growth rate in the phase 2 revenues in scenario 2.

Lastly, we multiply the number of employees by the same cost per employee calculated for scenario 2 of £105,818.

A.11 Compliance costs for non-AI firms that develop AI products In-house

This section describes how we model compliance costs incurred by non-AI firms that have in-house AI development, as those are not captured in the main analysis. We estimate an upper and lower range for these costs. We explain each of the two methodologies in turn.

A.11.1 Lower range estimate for non-AI firms' in-house AI development

For the lower range, we use a top-down approach and utilise the total compliance costs that would be incurred by all AI firms (before any of the firms' decisions are made). Since our model uses the assumption that 40% of total AI revenues are from in-house AI developers, the modelled costs for AI firms represent 60% of the AI market.

Assuming a linear relationship between expenditure share and compliance costs, we can calculate the compliance costs incurred by non-AI firms that develop in-house AI products:

$$Compliance\ cost\ for\ non\ AI\ firm\ in\ house\ development = \frac{40\%\ X\ (AI\ firms\ compliance\ costs)}{60\%}$$

This calculation is done for each year of the modelling horizon based on the growth rate in the number of firms and number of products following the same methodology described in sections A.3.2 and A.3.3.

[59] The assumption was agreed on with the DCMS team.

[60] Assuming that current regulators would enjoy some level of efficiencies and need less workforce to uphold AI regulation.

A.11.2 Upper range estimate for non-AI firms' in-house AI development

For the upper bound estimation, we use a bottom-up approach that models the number of non-AI firms that develop AI in-house and the compliance costs they would incur.

We start the calculation by estimating the number of small, medium and large non-AI firms developing AI products in-house. We use the total number of AI firms that adopt AI as estimated in the AI Activity in UK Businesses report and multiply it by the percentage of firms assumed to have in-house development for each size (based on page 28 in the AI activities in UK businesses report). We then assume the number of unique AI products that each non-AI firm size would be developing in-house. We assume that non-AI firms would have fewer AI products developed compared to AI firms and assume that small, medium and large businesses develop 1, 2 and 3 unique products, respectively.

We multiply the number of non-AI firms by the number of unique products to arrive at the total number of unique AI products developed. The results are presented in Table 21below.

Table 21 Non-AI firms with in-house AI developments, by size category

Size category	Number of total firms that adopt AI	Share of firms producing in-house	Number of firms producing in-house	Number of products per non-AI firm	Total number of AI products
Small	414,387	34%	140,892	1	140,892
Medium	12,080	49%	5,919	2	11,838
Large	5,204	40%	2,082	3	6,245

Source: Frontier Economics based on AI Activity in UK Businesses report (page 28).

A.11.3 Familiarisation costs

In addition to the total compliance costs that non-AI firms might face, we include a calculation of the additional familiarisation costs they might face. We assume that all non-AI firms that develop in-house AI systems would need to familiarise themselves with the regulation, regardless of the regulatory regime. As such, those costs are calculated once for both scenarios.

Using the estimates of £164 per product from familiarisation of regulation calculated in A.6.3 we can calculate the total familiarisation costs for non-AI firms. Since this is a one-off cost, we calculate it based on the 2023 (the first year of regulation) estimated growth of firms and products. Table 22 presents the familiarisation costs for the start of regulation in 2020 and 2023.

Table 22 Total familiarisation costs in 2020 and 2023 for non-AI firms

Number of firms adopting AI in 2020	Total number of AI products 2020	Total familiarisation costs in 2020	Total number of AI products 2023	Total familiarisation costs in 2023
Small	140,892	£22,542,653	157,344	£33,984,014
Medium	11,838	£1,894,144	6,610	£2,855,503
Large	6,245	£999,168	2,325	£1,506,289
Total	**158,975**	**£25,435,965**	**166,279**	**£38,345,806**

Source: Frontier Economics based on AI Activity in UK Businesses report.

Note: In our model, the start year of regulation is 2023

A.12 Modelling horizon and Net Present Value calculation

We project all our calculations for ten years - from 2023 to 2032 - without adding inflation. The Net Present Value of the ten-year horizon utilises a 3.5% discount rate, in line with the Green Book guidelines.[61]

[61] The Green Book - Central Government Guidance on Appraisal and Evaluation. Paragraph 5.35. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1063330/Green_Book_2022.pdf

Annex B - Stakeholder engagement summary

As part of this project, we conducted a focused stakeholder engagement where we interviewed 7 AI businesses, from different sectors and various sizes, one-on-one and conducted a workshop with an additional 7 AI businesses. These interviews were kept confidential to ensure honest and open conversations could take place. As such, we do not report a detailed review of the information we received from these conversations. Instead, we provide a high-level summary of the main findings following the broad themes discussed with the stakeholders:

1. The anticipated impact of the EU AI Act.
2. The impact of potential governance scenarios.
3. The implications of hypothetical international regulatory divergence

Please see Figure 3, Figure 4, Figure 5 below.

Figure 3 Main takeaways from the proposed EU AI Act

	Overall take away	Disparity of thoughts	Confidence level	Potential next steps (DCMS/Frontier)
Main concern	Lack of clarity about who is responsible for undertaking the conformity assessments (developers/deployers). Guidelines are not clear	**Low**. A consensus on this topic	High	**No further steps**
Main impact	Increase in costs and reduction in innovation	**Medium**. Answers varied between costs, investments and R&D	Medium/High	
Costs	• HRS conformity costs would be high. • Difference in views of costs impact mechanisms: 1. High costs/difficult regulation can cause some to drop from the market 2. Some/all the costs would be transferred to downstream businesses/customers 3. Incurred costs that are not transferred will impact levels of R&D/investment	**High.** Answers varied by business size, sector and development stage.	Medium	**Proposal or DCMS:** Investigate sector-specific trends. Business survey can reveal any specific sector impacts.
Consumer trust	Participants did not know the impact on customer trust	N/A	Low	**For Frontier:** Potential further conversations with experts and literature review. Might still be limited. **Proposal for DCMS:** Conduct end-user survey about how regulation may impact trust in AI.

Source: Frontier Economics

Figure 4 Main takeaways from hypothetical UK governance scenarios

	Overall take away	Disparity of thoughts	Confidence level	Potential next steps (DCMS/Frontier)
Ex-ante VS Ex-post	Slight preference for ex-post	**High** – some were not convinced that ex-post regulation will be effective	Medium/High	**No further steps.** Diversity in responses driven by whether the business already has conformity assessments in place
Minimal requirements VS voluntary code of conduct	Overall preference for minimal requirements as long as those are clear and not too burdensome Regulation can alleviate legal uncertainty Overall view that most (good) companies already have an internal risk assessment in any case	**Medium** - some think that voluntary code of conduct will not be effective	Medium/High	
Current regulators VS central AI regulator	No clear view A need to take into account AI with its specific characteristics but also be sector-specific	**Medium** – most have contradicted themselves, asking for both a central regulator and sectorial supervision	Medium	**Proposal for DCMS:** Further conversations with businesses to understand this aspect further

Source: Frontier Economics

Figure 5 Main takeaways from potential international regulatory divergence

	Overall take away	Disparity of thoughts	Confidence level	Potential next steps (DCMS/Frontier)
Preferred approach	The same global regulation but not the one proposed by the EU. Inconsistent view about whether businesses will apply the highest regulatory requirements to all areas or do the minimum in each jurisdiction.	**High**	Medium	**Proposal for DCMS:** Investigate sector-specific trends. Business survey can reveal any specific sector impacts.
Impact of divergence	Main impacts: • Costs are higher with higher divergence • Investments would go to the areas considered the most pro-innovation.	**High**	Medium	

Source: Frontier Economics