Unleashing Potential: The £23bn Economic Opportunity in UK Mathematical Sciences Ethnic Diversity

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Abstract

This brief quantifies the annual Gross Value Added (GVA) loss to the UK economy due to under-representation of ethnic minorities in mathematical-science occupations. Drawing on Deloitte's 2013 study and the Academy for the Mathematical Sciences' 2023 economic-contribution update (published in 2024), we employ a *population-based shortfall* approach, contrasting working-age population shares with sectoral workforce shares, and translate the resulting shortfall into GVA foregone. The analysis is explicitly anchored to the Academy's 2023 snapshot of 4.22 million mathematical-science (MS) workers contributing £495 billion GVA; a subsequent ground-up Academy analysis for 2024 estimates 5.11 million MS workers and £489 billion GVA and suggests that even a 1% increase in MS workers could be worth around £5 billion annually. The ethnic-representation logic developed here applies *mutatis mutandis* to that updated footprint. Detailed arithmetic, assumptions, limitations, and policy levers for companies and government are provided for transparency.

Contents

1 Introduction

The mathematical sciences underpin critical areas such as artificial intelligence (AI), data science, financial modelling, and cryptography. Deloitte's 2013 report demonstrated that 2.8 million UK jobs in 2010 relied on mathematical-science expertise, contributing £208 billion GVA in real terms [6]. The Academy for the Mathematical Sciences updated this analysis in 2024, finding 4.22 million such roles in 2023, contributing £495 billion GVA (around 20% of UK output) [1]. Both reports focus on *all* UK regions.

A subsequent, ground-up Academy analysis for 2024 estimates that 5.11 million people were working in mathematical-science occupations in 2024 (around 15% of UK employment), contributing £489 billion in direct GVA (19% of UK GVA), and concludes that even a 1% increase in MS workers could be worth approximately £5 billion to the UK economy [2]. This brief, however, deliberately remains anchored to the 2023 snapshot (4.22 million workers; £495 billion GVA), using those figures as the baseline for the ethnic-representation calculations; the under-representation geometry applies *mutatis mutandis* to the updated 2024 footprint.

Despite this growth, minoritised ethnic people remain under-represented: they comprise $s_p = 19.5\%$ of the working-age population (16–64) in England & Wales (Census 2021) [12], and we use that as a proxy for the UK. We believe this proxy to be reasonable given that England & Wales make up over 90% of the UK population and that Scotland and Northern Ireland have smaller and, on average, less ethnically diverse populations. To the extent that this holds, our UK-level estimates of ethnic-minority under-representation are, if anything, conservative. In contrast, minoritised ethnic people hold only $s_w = 14.8\%$ [1] of mathematical-science (MS) roles (APS Jul–Sep 2023, England & Wales), a gap of $\Delta s = 4.7$ pp. Closing this gap not only addresses equity but also taps an "innovation dividend," especially as AI and data-science roles expand rapidly in the coming decade.

Crucially, the under-representation of minority ethnicities in mathematical-science occupations is occurring within a broader context of a significant and documented skills shortage in the UK's mathematical sciences sector. The rise of big data, AI, and digitalisation has fundamentally increased the demand for professionals who can analyse, interpret, and model complex data. For instance, organisations have reported a shortage of data skills across the UK workforce, with potentially at least 178,000 unfilled data

[1] Details on the derivation of this figure can be found in Appendix B where we have chosen the value from Method 1 as corresponding to the middle figure.

specialist roles in 2021 [14]. Furthermore, there was a 6.2% growth in demand for jobs requiring undergraduate maths skills between 2019-2023 [4, 5]. The wider context of this challenge is reflected in the fact that skills shortage vacancies across all occupations in the UK more than doubled between 2017 and 2022, from 226,500 to 531,200 [7]. This persistent and growing demand highlights a genuine skills shortage across the Science, Technology, Engineering and Mathematics (STEM) fields, including mathematical sciences [15].

This diagnosis is echoed in the UK government's *AI Opportunities Action Plan*, which frames AI as a central lever for broad-based economic growth and emphasises the need to expand and diversify the UK's AI and data-science talent pipeline over the coming decade [3].

We implicitly assume that the mathematical-sciences sector will continue growing (as it did from 2.8M $\rightarrow$ 4.22M jobs between 2010–2023), and that a pool of ethnic-minority candidates—with the right skills—could be mobilised to fill an increasing number of MS roles. Put differently, reducing the representation gap is not primarily about redistributing a fixed stock of existing jobs, but about tapping into both (a) lagging talent pipelines and (b) emerging MS vacancies in AI, data science, actuarial work, etc. Knowing that a genuine skills shortage arises (i.e. demand outstrips supply even at full diversity), targeted education, upskilling, and lateral-hire interventions will be required sooner to prevent unfilled positions in high-growth areas and to realise this growth opportunity.

2 Population-Based Shortfall

2.1 Overview

We compare the share of ethnic minorities in the working-age population against their observed share in mathematical-science roles. The percentage-point shortfall translates to a number of *missing* jobs, which we monetise via the per-worker GVA.

2.2 Inputs and Data Sources

- Total MS employment: $M = 4.22 \times 10^6$ workers [1].
- Average GVA per MS worker: $v = \pounds 117{,}000$ [1].
- Working-age population (16–64): $P = 41.7 \times 10^6$ [11].
- Minority ethnic working-age share: $s_p = 19.5\%$ [12].
- Observed ethnic-minority share in MS roles: $s_w = 14.8\%$.

These figures correspond to the Academy's updated 2023 economic-contribution analysis. The Academy's subsequent 2024 ground-up study estimates 5.11 million MS workers and £489 billion GVA [2]; if one were to re-run the calculations in this brief on that updated baseline, the absolute £-values would change slightly but the proportional under-representation geometry—and hence the core economic argument—would remain the same.

2.3 Calculations

Define the shortfall:

$$\Delta s = s_p - s_w = 0.195 - 0.148 = 0.047.$$

Missing jobs:

$$\text{Jobs}_{\text{gap}} = M \times \Delta s = 4.22 \times 10^6 \times 0.047 \approx 198{,}340.$$

Annual GVA lost:

$$\text{GVA}_{\text{gap}} = \text{Jobs}_{\text{gap}} \times v \approx 198{,}340 \times 117{,}000 \approx \pounds 23.2 \text{ bn}.$$

2.4 Assumptions and Limitations

The quantification of economic opportunity in this brief is based on a specific methodology and set of data. As with any such analysis, it rests on several assumptions and is subject to certain limitations. Understanding these is crucial for proper interpretation of the results and for guiding future research.

- **Professional Occupations as a Proxy for MS Roles:** We have approximated "mathematical-science roles" using broad categories of "Professional occupations" and "Associate professional and technical occupations" from ONS Standard Occupational Classification (SOC) data.
  - **Implication:** This proxy may not perfectly align with the precise definition of mathematical-science roles (which could be narrower or broader depending on the specific study, e.g., including statisticians, data scientists, economists, engineers, etc.). This could lead to either an overestimation or underestimation of the true MS workforce size and, consequently, the GVA figures if the proportion of ethnic minorities within the "true" MS roles differs significantly from our proxy. Future work could refine this by mapping specific SOC codes more granularly to mathematical science competencies.
- **Geographic scope**: Minoritised-ethnic data (Census 2021, APS 2023) cover England & Wales, whereas GVA figures cover the full UK.
  - **Implication:** We treat England & Wales as a proxy for the UK in the absence of fully comparable UK-wide ethnicity-by-occupation microdata. England & Wales account for over 90% of the UK population and Scotland and Northern Ireland tend to have more homogeneous (more White) populations. As a result, our estimated UK-wide under-representation is likely to be, if anything, conservative.
- **Static Sectoral Minoritised ethnic Shares (for Method 2 & 3):** For certain methods, we assume that the proportional representation of ethnic minorities within specific economic sectors, or within aggregated occupational categories, has remained constant over time (e.g., using 2010 or 2021 ethnic share data for 2023 calculations).
  - **Implication:** If the ethnic composition within sectors or professional groups has changed significantly between the data collection year (e.g., 2010 or 2021) and the target year (2023), our weighted averages may not fully capture the

most current reality. Dynamic shifts in demographics, educational attainment, or recruitment practices within specific sectors could alter these proportions. More recent granular data, if available, would provide a more accurate baseline.

- **No Zero-Sum Game for Job Creation/Redistribution:** The analysis frames the "gap" as a potential for economic growth (i.e., new jobs or increased productivity from filling existing roles more efficiently), rather than a reallocation or displacement of existing non-ethnic minority workers.
  - **Implication:** This assumption aligns with the idea of an "innovation dividend" where a more diverse workforce can drive new ideas and expanded economic activity. If the economic landscape were truly static or contracting, filling this gap might imply a zero-sum redistribution of existing roles. However, given the strong growth trajectory of the mathematical sciences sector, and the Academy's estimate that even a 1% increase in MS workers could be worth about £5 billion in additional GVA each year [2], the "growth opportunity" framing is considered appropriate for this brief.
- **Data Granularity and Ad-Hoc APS Tables (for s_w):** The observed ethnic-minority share in MS roles ($s_w = 14.8\%$) is derived from ad-hoc analysis of APS (Annual Population Survey) tables, utilizing SIC2-level (Standard Industrial Classification 2-digit) data.
  - **Implication:** While the APS is a robust source, reliance on ad-hoc tables and aggregated SIC2-level data means that very specific niches within mathematical sciences might not be perfectly captured. More detailed or purpose-built surveys focusing specifically on the mathematical sciences workforce would provide finer-grained insights. The use of proxy occupational categories (as mentioned above) is a related limitation stemming from data availability.
- **Average GVA per Worker as a Homogeneous Metric:** The calculation uses a single average GVA per MS worker ($£117,000$) across the entire sector.
  - **Implication:** This assumes that all mathematical science roles contribute equally to GVA, regardless of the specific sub-field, experience level, or sector. In reality, GVA contributions can vary significantly (e.g., a data scientist in tech might have a different GVA impact than a mathematician in academia). If minoritised ethnic workers are disproportionately concentrated in lower-GVA roles (or vice-versa), the calculated economic opportunity might be slightly different.
- **Causality of GVA Loss:** The brief quantifies the *correlation* between under-representation and GVA opportunity. It assumes that filling the representation gap would directly lead to the calculated GVA increase.
  - **Implication:** While diversity is generally associated with innovation and economic growth, isolating the exact causal link between closing this specific demographic gap and the precise GVA figure can be complex. Other factors (e.g., educational quality, investment in R&D, general economic climate) also heavily influence GVA. The analysis assumes that the "missing" workers would generate GVA at the average rate.

In reality, numerous studies show that increased team diversity correlates with higher innovation, better problem-solving, and often materially higher productivity, especially in data- and research-intensive fields. McKinsey's extensive research, for example, consistently demonstrates a positive correlation between leadership diversity (both gender and ethnic/cultural) and financial outperformance [9, 8]. Companies in the top quartile for ethnic diversity on executive teams, for instance, were 39% more likely to financially outperform those in the bottom quartile [8]. Other studies also highlight that diverse workforces boost productivity and patent citations, and more diverse companies are significantly more likely to capture new markets [16].

If a more diverse MS workforce outperforms the existing average in terms of innovation and problem-solving, then the true economic benefit of closing the representation gap could exceed the calculated £23.2bn per year. Conversely, if barriers confine ethnic-minority hires to lower-GVA niches, the average might be lower. Therefore, while we apply a uniform £117,000/worker figure, we note that diversity-driven productivity gains could further amplify the GVA impact beyond this baseline calculation.

3 Policy Levers

To effectively address the under-representation of ethnic minorities and unlock the full economic potential of the mathematical sciences, a comprehensive and coordinated strategy is essential. This requires deliberate action across various stages of the talent pipeline and career progression. The following key levers, requiring collaborative efforts from both companies and government, are crucial for driving sustainable change:

1. **Grow the Pipeline of New Entrants:** This lever focuses on increasing the number of minoritised ethnic individuals pursuing mathematical science education and early career paths.

    - **Company Actions:**
        - **Partner with universities on scholarships and bursaries:** Targeted financial support for minoritised ethnic students in STEM, particularly mathematical sciences, can significantly reduce barriers to entry and progression.
        - **Sponsor conversion MScs and postgraduate programmes:** Support for graduates from non-mathematical backgrounds to acquire essential mathematical skills can broaden the talent pool.
        - **Develop inclusive internship and apprenticeship programmes:** Early exposure and structured pathways into MS roles for diverse students can demystify the sector and build confidence.
    - **Government Actions:**
        - **Increase funded STEM-math degree places:** Expanding university capacity in relevant fields can meet rising demand and allow for greater diversity.

    - **Fund conversion-course bursaries and scholarships:** Government-backed financial aid can incentivise individuals to reskill or upskill into mathematical sciences.
    - **Promote mathematical sciences in schools (Key Stages 3/4):** Invest in programmes that highlight career opportunities and make mathematics engaging for diverse student populations from an early age. Educational and outreach interventions, such as programmes in Key Stages 3–4, typically take 5–10 years to translate into graduates entering the MS workforce. Therefore, while interventions at Key Stage 3 are essential for long-term diversity, more immediate levers (e.g., conversion MSc, apprenticeships, lateral upskilling) are also critical to achieve near-term improvements. Policymakers and companies should adopt a dual-track strategy, combining immediate and long-term approaches, such as the scenarios highlighted in this paper, to ensure both rapid impact and sustained growth in the diversity of the mathematical sciences talent pipeline.

2. **Enable Lateral Transitions and Upskilling:** This lever targets individuals already in the workforce who may benefit from re-skilling or upskilling into mathematical science roles, or transitioning from other sectors.

    - **Company Actions:**
        - **Run internal apprenticeships and bootcamps:** Develop in-house training programmes to equip existing employees from diverse backgrounds with new mathematical skills for career advancement.
        - **Offer structured mentorship and sponsorship programmes:** Pair aspiring minoritised ethnic professionals with senior leaders to guide career development and promote visibility.
        - **Implement skills-based hiring:** Focus recruitment on demonstrable skills rather than traditional qualifications alone, which can broaden the pool of eligible diverse candidates.
    - **Government Actions:**
        - **Expand national skills bootcamp funding:** Increase investment in intensive, short-term training programmes focused on in-demand mathematical and digital skills.
        - **Provide employer upskling tax credits or grants:** Incentivise companies to invest in the professional development and re-training of their existing diverse workforce.
        - **Support career change initiatives:** Develop public-sector programmes that assist individuals from underrepresented groups in pivoting to mathematical science careers.

3. **Create Inclusive Environments and New MS Roles:** This lever focuses on ensuring that the mathematical sciences sector is an attractive and equitable place to work for minoritised ethnicities, and on actively expanding opportunities.

    - **Company Actions:**
        - **Allocate diversity targets in R&D and new headcount recruitment:** Set explicit, measurable goals for increasing minoritised ethnic

representation in teams and leadership, especially in growing areas like AI and data science.

  - **Launch inclusive AI/data labs and innovation hubs:** Foster environments that celebrate diverse perspectives and actively counter unconscious biases in team formation and project development.
  - **Review and reform hiring and promotion processes:** Address systemic biases in job descriptions, interview panels, and performance evaluations to ensure fairness and equal opportunity for diverse candidates.

- **Government Actions:**
  - **Target R&D tax incentives at diverse SMEs:** Encourage smaller businesses with strong diversity commitments or leadership to innovate and create MS roles.
  - **Commission public-sector MS centers of excellence with diversity mandates:** Establish government-funded hubs with explicit goals for diverse recruitment and inclusive practices, serving as a model for the wider industry.
  - **Promote data collection and transparency:** Mandate or encourage disaggregated diversity reporting within sectors to track progress and identify areas for intervention.

Coordinated action across these three interconnected levers—from cultivating early talent to fostering inclusive workplaces—is paramount. By simultaneously addressing pipeline, progression, and cultural inclusion, the UK can accelerate the closing of its ethnic diversity gap in mathematical sciences, thereby realizing a significant economic and social dividend.

4 Implementation Timeline

Closing the observed representation gap of $\Delta s = 4.7$ percentage points requires a sustained and accelerated growth in the number of minoritised ethnicities entering and progressing within mathematical-science roles. To raise the observed minoritised-ethnic share in MS roles (s_w) from its current value of 0.148 to the working-age population share ($s_p = 0.195$) over a target period of t years, the minoritised-ethnic MS headcount must grow at an annual rate (r_m) satisfying the following relationship:

$$(1 + r_m)^t = (1 + r_{\mathrm{MS}})^t \frac{s_p}{s_w},$$

where $r_{\mathrm{MS}} \approx 3.11\%/\mathrm{yr}$ is the overall Compound Annual Growth Rate (CAGR) of the mathematical-science workforce (from 2.83 million in 2010 to 4.22 million in 2023, based on [6] and [1]). Solving this equation for r_m yields:

$$r_m(t) = (1 + r_{\mathrm{MS}})\left(\frac{s_p}{s_w}\right)^{1/t} - 1.$$

This formula reveals the necessary premium on minoritised-ethnic growth compared to the baseline growth of the entire MS workforce. The following scenarios provides the implications for different target timelines:

- **Aggressive Target ($t = 5$ years):** To reach parity by 2028 (i.e., in $t = 5$ years), r_m would need to be approximately $r_m(5) = (1 + 0.0311)\left(\frac{0.195}{0.148}\right)^{1/5} - 1 \approx 0.0896$, or 8.96%/yr. This represents a significant premium of $8.96\% - 3.11\% = 5.85$ percentage points per year (or $\approx$ 238,068 additional workers over the 5 years) over the baseline MS growth[2]. Achieving this would require highly impactful, accelerated, and coordinated policy and corporate actions.

- **Moderate Target ($t = 10$ years):** To reach parity by 2033 (i.e., in $t = 10$ years), r_m would need to be approximately $r_m(10) = (1 + 0.0311)\left(\frac{0.195}{0.148}\right)^{1/10} - 1 \approx 0.0599$, or 5.99%/yr. This translates to a premium of $5.99\% - 3.11\% = 2.88$ percentage points per year (or $\approx$ 251,177 additional workers over the 10 years). While still ambitious, this timeline allows for a more incremental, yet consistent, increase in ethnic minority representation.

- **Longer-Term Target ($t = 15$ years):** To reach parity by 2038 (i.e., in $t = 15$ years), r_m would need to be approximately $r_m(15) = (1 + 0.0311)\left(\frac{0.195}{0.148}\right)^{1/15} - 1 \approx 0.0502$, or 5.02%/yr. This implies a premium of $5.02\% - 3.11\% = 1.91$ percentage points per year (or $\approx$ 270,749 additional workers over the 15 years). This timeline offers a more gradual approach, potentially allowing for organic growth and the full impact of longer-term educational and societal changes.

These calculations highlight that closing the diversity gap within a reasonable timeframe necessitates specific interventions that drive minoritised-ethnicity participation rates at a pace significantly exceeding the overall growth of the mathematical sciences sector. The scale of this required differential growth underscores the urgency and strategic importance of the policy levers outlined in Section 3.

From a policy perspective, the shorter-horizon scenario ($t = 5$) should be interpreted as relying predominantly on mid-career reskilling, conversion MScs, accelerated recruitment and progression, and lateral transitions into mathematical-science roles, because school-level interventions (for example at Key Stages 3–4) will not yet have fed through into the labour market. The 10- and 15-year scenarios are more naturally aligned with structural pipeline reforms in schools and universities, coupled with sustained improvements in retention and progression in the workplace. This reinforces the case for a dual-track approach: immediate action on reskilling and recruitment, alongside longer-term educational and pipeline reform.

5 Conclusions

This brief has quantified the substantial economic cost of under-representation of ethnic minorities in the UK's vital mathematical sciences sector. Our analysis reveals that the current participation gap translates to an annual Gross Value Added (GVA) shortfall of nearly £23.2 billion. This figure underscores not just a missed opportunity, but a significant drag on national productivity and innovation potential.

The imperative to address this disparity is twofold: it is a moral imperative rooted in equity and social justice, ensuring that talent from all backgrounds can contribute and thrive. Crucially, it is also a powerful economic imperative. As demonstrated by

[2]The calculations for this as well as for the other scenarios are given in Appendix C

the required differential growth rates, closing this gap presents a tangible "innovation dividend" that can accelerate the expansion of the mathematical sciences workforce, particularly in high-growth areas like AI and data science.

Achieving this transformative change necessitates a concerted and collaborative effort. The policy levers outlined in this brief — focusing on cultivating diverse new entrants, enabling strategic lateral transitions and upskilling, and fostering truly inclusive professional environments — require sustained commitment from both corporate leaders and government policymakers.

By proactively investing in and championing ethnic diversity within mathematical sciences, the UK can not only rectify a persistent inequity but also unleash a powerful engine for future economic growth, securing its position as a global leader in innovation and research. The time for decisive action is now.

A Mapping Mathematical Science Jobs to ONS Sectors

A.1 Python Code Used for Mapping

```
import pandas as pd

# Load the Excel file
excel_path = "/.../your-file.xlsx"
xls = pd.ExcelFile(excel_path)

# Read and clean the sheet
df = xls.parse('Sheet1', skiprows=3)
df = df.rename(columns={"Sector in model": "Sector", "Jobs maths
   ↪ science": "Jobs"})
df = df.dropna(subset=["Sector"])
df["Jobs"] = pd.to_numeric(df["Jobs"], errors='coerce').fillna(0).
   ↪ astype(int)
df["Sector_clean"] = df["Sector"].str.lower().str.strip()

# Single comprehensive mapping from Deloitte sector labels to ONS
   ↪ sectors
sector_to_ons = {
    # A - Agriculture, forestry and fishing
    "agriculture": "A",
    "forestry": "A",
    "fishing": "A",

    # B,D,E - Energy and water
    "coal extraction": "B,D,E",
    "oil and gas extraction": "B,D,E",
    "metal ores extraction, other mining and quarrying": "B,D,E",
    "electricity production & distribution": "B,D,E",
    "gas distribution": "B,D,E",
    "water supply": "B,D,E",
```

```
# C - Manufacturing
"meat processing": "C",
"fish and fruit processing": "C",
"oils and fats processing": "C",
"dairy products": "C",
"grain milling and starch": "C",
"animal feed": "C",
"bread, biscuits etc": "C",
"sugar": "C",
"confectionery": "C",
"other food products": "C",
"alcoholic beverages": "C",
"soft drinks & minerals": "C",
"tobacco products": "C",
"textile fibres, textile weaving, textile finishing": "C",
"made-up textiles, carpets and rugs, other textiles, knitted
   ↪ goods": "C",
"wearing apparel & fur products": "C",
"leather goods, footwear": "C",
"wood and wood products": "C",
"pulp, paper and paperboard": "C",
"paper and paperboard products": "C",
"printing and publishing": "C",
"coke ovens. refined petroleum & nuclear fuel": "C",
"industrial gases and dyes": "C",
"inorganic chemicals, organic chemicals": "C",
"fertilisers, plastics & synthetic resins etc,": "C",
"pesticides": "C",
"paints, varnishes, printing ink etc": "C",
"pharmaceuticals": "C",
"soap and toilet preparations": "C",
"other chemical products, man-made fibres": "C",
"rubber products": "C",
"plastic products": "C",
"glass and glass products": "C",
"ceramic goods": "C",
"structural clay products, cement, lime and plaster": "C",
"articles of concrete, stone etc ": "C",
"iron and steel, non-ferrous metals, metal castings": "C",
"structural metal products": "C",
"metal boilers & radiators": "C",
"metal forging, pressing, etc": "C",
"cutlery, tools etc": "C",
"other metal products": "C",
"mechanical power equipment": "C",
"general purpose machinery": "C",
"agricultural machinery": "C",
"machine tools": "C",
"special purpose machinery": "C",
"weapons and ammunition": "C",
"domestic appliances not elsewhere classified": "C",
```

```
"office machinery & computers": "C",
"electric motors and generators etc,": "C",
"insulated wire and cable": "C",
"electrical equipment not elsewhere classified": "C",
"electronic components": "C",
"transmitters for tv, radio and phone": "C",
"receivers for tv and radio": "C",
"medical and precision instruments": "C",
"aircraft and spacecraft": "C",
"shipbuilding and repair": "C",
"motor vehicles": "C",
"other transport equipment": "C",
"furniture": "C",
"jewellery & related products": "C",
"sports goods and toys": "C",
"miscellaneous manufacturing not selsewhere classified,
    ↪ recycling": "C",

# F - Construction
"construction": "F",
"architectural activities & tech. consult": "F",

# G,I - Distribution, hotels and restaurants
"motor vehicle distribution & repair, fuel": "G,I",
"wholesale distributlon": "G,I",
"retail distribution": "G,I",
"hotels, catering, pubs etc": "G,I",

# H,J - Transport and communication
"water transport": "H,J",
"railway transportation": "H,J",
"other land transportation": "H,J",
"air transport": "H,J",
"ancillary transport services": "H,J",
"postal and courier services": "H,J",
"telecommunications": "H,J",

# K,L,M,N - Banking and finance
"banking and finance": "K,L,M,N",
"insurance and pension funds": "K,L,M,N",
"auxiliary financial services": "K,L,M,N",
"owning and dealing in real estate": "K,L,M,N",
"letting of dwellings": "K,L,M,N",
"e.state agent activities": "K,L,M,N",
"renting of machinery etc": "K,L,M,N",
"computer services": "K,L,M,N",
"research and development": "K,L,M,N",
"legal activities": "K,L,M,N",
"accountancy services": "K,L,M,N",
"market research, management consultancy": "K,L,M,N",
"advertising": "K,L,M,N",
```

```
    "other business services": "K,L,M,N",

    # O,P,Q - Public admin, education and health
    "public administration & defence": "O,P,Q",
    "education": "O,P,Q",
    "health and veterinary services": "O,P,Q",
    "social work activities": "O,P,Q",
    "sewage and sanitary services": "O,P,Q",

    # R,S,T,U - Other services
    "membership of organisation not elsewhere classified": "R,S,T,U",
    "recreational services": "R,S,T,U",
    "other service activities": "R,S,T,U"
}

# Apply single unified mapping
df["ONS Sector"] = df["Sector_clean"].map(sector_to_ons)

# Ensure all 9 sectors are represented
ons_sector_list = ["A", "B,D,E", "C", "F", "G,I", "H,J", "K,L,M,N", "O,P,Q", "R,S,T,U"]
sector_totals = df.groupby("ONS Sector")["Jobs"].sum().to_dict()
for sector in ons_sector_list:
    sector_totals.setdefault(sector, 0)

# Format the final DataFrame and total
final_df = pd.DataFrame(list(sector_totals.items()), columns=["ONS Sector", "Total Jobs"]).sort_values("ONS Sector").reset_index(drop=True)
grand_total = final_df["Total Jobs"].sum()

# Display result
print(final_df)
print("\nTotal Jobs:", grand_total)
```

A.2 Table of Jobs by ONS Sector

A.3 Bar Chart of Job Distribution

Table 1: Mathematical Science Jobs by ONS Sector

ONS Sector	Total Jobs
A	1,000
B,D,E	91,300
C	374,500
F	418,500
G,I	72,600
H,J	132,300
K,L,M,N	974,600
O,P,Q	570,100
R,S,T,U	191,200

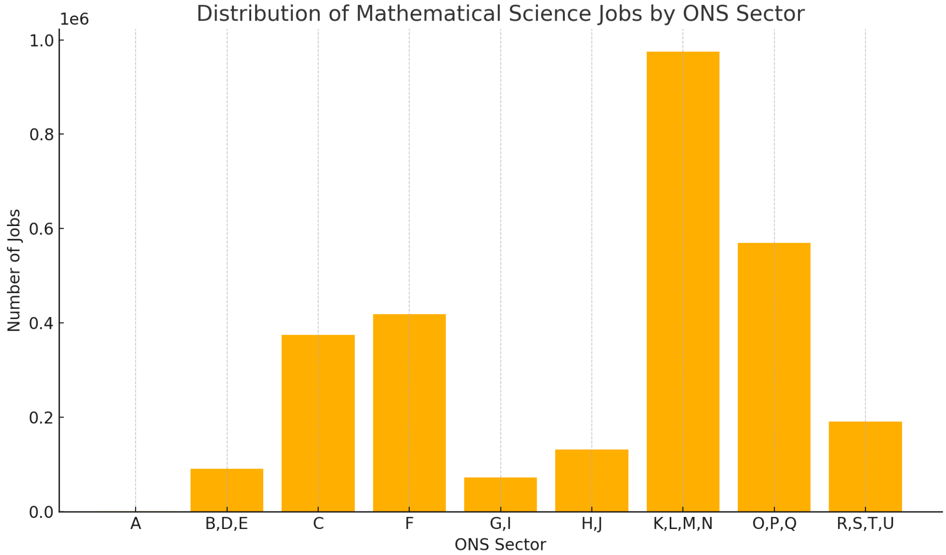

Figure 1: Distribution of Mathematical Science Jobs by ONS Sector

B Derivation of Ethnic Minority Share in Mathematical Science Roles

In this section we detail three methods used to determine plausible values of the minoritised ethnic share of mathematical science roles.

B.1 Method 1

The figure of 14.8% for the observed share of ethnic minorities in mathematical science roles (denoted as s_w) is derived from analysis of data, specifically from the Office for National Statistics (ONS) Census 2021 dataset, *RM104: Occupation by ethnic group* [10]. This dataset provides detailed estimates classifying usual residents aged 16 years and over in employment by their occupation and ethnic group in England and Wales.

B.1.1 Key Column Entries in the RM104 Dataset

The *RM104 dataset*, available from the ONS contains the following key dimensions relevant to this derivation:

- **Occupation (current)**: This classifies individuals aged 16 and over by their main job, using the Standard Occupational Classification (SOC) 2020. This classification is hierarchical, allowing for aggregation from detailed four-digit SOC codes up to broader one-digit major groups. For mathematical science roles, relevant categories would typically fall under "Professional occupations," and "Associate professional and technical occupations".
- **Ethnic group**: This dimension captures the self-identified ethnic group of individuals. The Census 2021 provides detailed categories, which can be aggregated into broader groups (e.g., Asian, Black, Mixed, Other, and White). For the purpose of "ethnic minorities," this typically includes all groups excluding the "White: English, Welsh, Scottish, Northern Irish or British" category, and sometimes other "White" sub-categories depending on the definition.
- **Observation**: This column represents the count of individuals (in persons) corresponding to each specific combination of occupation and ethnic group.

B.1.2 Derivation of the Percentage Figure

We assume that the percentage of minoritised ethnic people working in the mathematical sciences corresponds to the percentage of those persons that occupy professional and associate professional and technical positions. The following method was applied using the RM104 dataset:

1. **Identify Relevant Occupations**: First, identify the specific SOC 2020 occupation codes that constitute "mathematical science roles." In our case these were "Professional occupations" (e.g., IT professionals, scientists, engineers) and "Associate professional and technical occupations" that align with mathematical science expertise.
2. **Sum Total Employment in Relevant Occupations**: Sum the number of "Persons" across all identified occupation categories to get the total employment (N_{MS}) in these roles, irrespective of ethnic group.
3. **Sum Ethnic Minority Employment in Relevant Occupations**: For each of the identified occupation categories, sum the number of "Persons" belonging to all defined "ethnic minority" groups. This yields the total ethnic minority employment ($N_{\text{EM, MS}}$) within these roles.
4. **Calculate the Percentage**: The percentage (s_w) is then calculated as the ratio of ethnic minority employment in these roles to the total employment in these roles, multiplied by 100:
$$s_w = \frac{N_{\text{EM, MS}}}{N_{\text{MS}}} \times 100\%$$

The specific figure of 14.8% is the result of performing these calculations (to 1 decimal place of accuracy) on the detailed data from the ONS RM104 dataset.

B.2 Method 2: Sector-Specific Ethnic Share Weighting

This alternative method focuses on determining the percentage of minoritised ethnic people working specifically within the aggregated ONS sectors identified as having a significant mathematical science workforce. This approach integrates sector-level ethnic diversity data with the distribution of mathematical science jobs across these sectors.

B.2.1 Data Source and Sectoral Ethnic Share

This method utilizes data from the Office for National Statistics' "Employment by sector" dataset for the year 2010, accessible via the Ethnicity Facts and Figures service [13]. From this dataset, the "ethnic share" (percentage of minoritised ethnic workers) is determined for each of the broad ONS sectors that contain mathematical science roles.

B.2.2 Calculations and Weighted Average

The "Ethnic share" for each sector is then combined with the mapped numbers of mathematical scientist employees within those sectors (from the Deloitte 2013 analysis). The following table summarizes these inputs:

Table 2: Mathematical Science Jobs and Ethnic Share by ONS Sector (2010)

ONS Sector	Total Jobs	Ethnic share (%)
A	1,000	0.86
B,D,E	91,300	5.52
C	374,500	7.05
F	418,500	4.67
G,I	72,600	14.83
H,J	130,100	13.94
K,L,M,N	1,036,900	11.54
O,P,Q	650,400	11.42
R,S,T,U	50,700	9.52

The "Ethnic share" in each sector is weighted by the "Total Jobs" (representing the number of mathematical scientists in that sector), summed over each sector and this value is then divided by the sum of total jobs to calculate a weighted average. This weighted average, which is 9.86%, represents the overall percentage of minoritised ethnic workers within the mathematical science workforce for 2010, based on this sectoral approach.

B.2.3 Adjustment for 2023 Employment

To adjust this 2010-based figure to reflect the current scale of the mathematical science workforce, the calculated 9.86% is then multiplied by the ratio of total mathematical science employment in 2023 (from the Academy for the Mathematical Sciences' analysis [1]) to that in 2010 (from the Deloitte analysis [6]).

The adjustment factor is:

$$\text{Adjustment Factor} = \frac{\text{MS Employment}_{2023}}{\text{MS Employment}_{2010}} = \frac{4.2 \text{ million}}{2.83 \text{ million}}$$

This ratio is then applied to the 9.86% weighted average to provide an updated estimate (14.63%) of ethnic minority representation in mathematical science roles for 2023 based on this second method.

B.3 Method 3

In this method we assume that the proportions of minoritised ethnic persons working (in 2023) in ONS sectors A through R,S,T,U are the same as for 2010. More specifically for each sector the weight is derived by dividing the 2010 number of jobs by the total number of jobs. Thus for sector A this would be 1,000/2,830,000. We then multiply each weight by the ethnic share derived from repeating the calculations in B.2.2 but this time using the figures from the 2021 census from the ONS datasheet. The following provides a description of the results:

Table 3: 2010 weights applied to 2021 ethnic share

Sector	Weight	Ethnic share
A	0.000354	2.80%
B,D,E	0.032307	9.52%
C	0.132519	10.34%
F	0.148089	7.47%
G,I	0.02569	15.60%
H,J	0.046037	19.42%
K,L,M,N	0.366914	16.24%
O,P,Q	0.230149	16.24%
R,S,T,U	0.017941	10.83%

The result of multiplying and summing the weight by the ethnic share is 13.97%. If we now determine the CAGR we derive a figure of ≈ 3.22% which is the annual growth rate over the 11 years. To get this into 2023 numbers we compound the weighted sum 13.97% over two years at the rate of 3.22% per annum and we get 14.88%.

C Additional ethnic workers over baseline

C.1 Formula to determine additional workers

The following formula is used to determine the additional workers (over the baseline):

$$A_t \;=\; \bigl(M_0\,(1+G_r)^t\bigr) \;\times\; G_a,$$

where:

$$\begin{aligned}
A_t &= \text{Additional ethnic-minority workers required in year } t,\\
M_0 &= 4.22\times10^6\times0.148 \;=\; 624\,560,\\
G_r &= \text{Compound annual growth rate for ethnic-minority headcount},\\
G_a &= G_r \;-\; 0.0311 \;=\; (\text{ethnic CAGR}) \;-\; (\text{baseline } 3.11\%),\\
t &= \text{Number of years since 2023.}
\end{aligned}$$

Detailed Tables for Each Scenario

For each of the following scenarios, the result off the calculations have been rounded up to the next highest integer.

Aggressive Target (5 Years)

- Required annual growth rate for minoritised ethnic workers (G_r): 8.96% (0.0896)
- Premium growth rate: 5.85% (0.0585)

Year (N)	Total EM Workers at Year-End	5.85% of Year-End Total
1 (2024)	680,521	39,811
2 (2025)	741,496	43,378
3 (2026)	807,934	47,265
4 (2027)	880,325	51,500
5 (2028)	959,202	56,114

Cumulative Total: 238,068 additional minoritised ethnic workers

Moderate Target (10 Years)

- Required annual growth rate for minoritised ethnic workers (G_r): 5.99% (0.0599)
- Premium growth rate: 2.88% (0.0288)

Year (N)	Total EM Workers at Year-End	2.88% of Year-End Total
1 (2024)	661,972	19,065
2 (2025)	701,625	20,207
3 (2026)	743,653	21,418
4 (2027)	788,198	22,701
5 (2028)	835,412	24,060
6 (2029)	885,454	25,502
7 (2030)	938,493	27,029
8 (2031)	994,709	28,648
9 (2032)	1,054,293	30,364
10 (2033)	1,117,446	32,183

Cumulative Total: 251,171 additional minoritised ethnic workers

Longer-Term Target (15 Years)

- Required annual growth rate for minoritised ethnic workers (G_r): 5.02% (0.0502)
- Premium growth rate: 1.91% (0.0191)

Year (N)	Total EM Workers at Year-End	1.91% of Year-End Total
1 (2024)	655,913	12,528
2 (2025)	688,840	13,157
3 (2026)	723,420	13,818
4 (2027)	759,736	14,511
5 (2028)	797,875	15,240
6 (2029)	837,929	16,005
7 (2030)	879,994	16,808
8 (2031)	924,170	17,652
9 (2032)	970,564	18,538
10 (2033)	1,019,287	19,469
11 (2034)	1,070,456	20,446
12 (2035)	1,124,193	21,473
13 (2036)	1,180,628	22,550
14 (2037)	1,239,896	23,683
15 (2038)	1,302,139	24,871

Cumulative Total: 270,743 additional minoritised ethnic workers

References

[1] Academy for the Mathematical Sciences. *New analysis shows that mathematical sciences supercharges UK economic growth.* October 2024. https://www.acadmathsci.org.uk/2024/10/22/new-analysis-shows-that-mathematical-sciences-supercharges-uk-economic-growth/ Accessed 15 November 2025.

[2] Rajpaul, V. M. & Marr, C. (2025). *Economic contribution of the UK mathematical sciences: an updated & refined quantification.* Academy for the Mathematical Sciences. https://doi.org/10.5281/zenodo.17117973 Accessed 15 November 2025.

[3] Department for Science, Innovation & Technology. (2025). *AI Opportunities Action Plan.* Independent report presented to Parliament, CP 1241, 13 January 2025. Available at: https://www.gov.uk/government/publications/ai-opportunities-action-plan/ai-opportunities-action-plan. Accessed 15 November 2025.

[4] Campaign for Mathematical Sciences (CaMS). (Undated). *Written evidence submitted by Campaign for Mathematical Sciences (ITN0012) to the House of Lords Science and Technology Committee.* Available at: https://committees.parliament.uk/writtenevidence/141382/pdf/ Accessed 2 June 2025.

[5] Campaign for Mathematical Sciences (CaMS). (Undated). *Written evidence submitted by Campaign for Mathematical Sciences (MTS0001) to the House of Lords Science and Technology Committee.* Available at: https://committees.parliament.uk/writtenevidence/139522/pdf/ Accessed 2 June 2025.

[6] Deloitte. *Measuring the Economic Benefits of Mathematical Science Research in the UK.* 2013. https://www.ukri.org/wp-content/uploads/2022/07/

EPSRC-050722-MeasuringEconomicBenefitsMathematicalScienceResearchUK.pdf Accessed 2 June 2025.

[7] Department for Education. (2023). *Employer Skills Survey 2022: UK Results*. Available at: https://dera.ioe.ac.uk/id/eprint/40392/ Accessed 2 June 2025.

[8] McKinsey & Company. (2023). *Diversity matters even more: The case for holistic impact*. Available at: https://www.mckinsey.com/featured-insights/diversity-and-inclusion/diversity-matters-even-more-the-case-for-holistic-impact Accessed 2 June 2025.

[9] Dixon-Fyle, S., Dolan, K., Hunt, V., & Prince, S. (2020). *Diversity wins: How inclusion matters*. McKinsey & Company. Available at: https://www.mckinsey.com/featured-insights/diversity-and-inclusion/diversity-wins-how-inclusion-matters Accessed 2 June 2025.

[10] Office for National Statistics. *Occupation by ethnic group: Census 2021*. Released 29 March 2023. https://www.ons.gov.uk/datasets/RM104/editions/2021/versions/3 Accessed 2 June 2025.

[11] Office for National Statistics. *Mid-2023 population estimates*. 2024. https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates Accessed 2 June 2025.

[12] Office for National Statistics. *Working-age population by ethnicity, England and Wales: 2021 Census*. 2022. https://www.ethnicity-facts-figures.service.gov.uk/uk-population-by-ethnicity/demographics/working-age-population/latest/ Accessed 2 June 2025.

[13] Office for National Statistics. *Employment by sector*. Data for 2010 accessed from Ethnicity Facts and Figures. https://www.ethnicity-facts-figures.service.gov.uk/work-pay-and-benefits/employment/employment-by-sector/latest/ Accessed 2 June 2025.

[14] Parliamentary Office of Science and Technology (POST). (2023). *Data Science Skills in the UK Workforce (POSTnote 697)*. Available at: https://post.parliament.uk/research-briefings/post-pn-0697/ Accessed 2 June 2025.

[15] Prospects Luminate. (Undated). *The UK's STEM skills shortage*. Available at: https://luminate.prospects.ac.uk/the-uks-stem-skills-shortage Accessed 2 June 2025.

[16] Gowdy, J. (2024). *How embracing diversity and inclusion can boost innovation*. CPI. Available at: https://www.uk-cpi.com/blog/how-embracing-diversity-and-inclusion-can-boost-innovation Accessed 2 June 2025.