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Policy brief

Women, innovation and productivity

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Introduction

There is plenty of evidence pointing to the fact that a lack of diversity, and more specifically a lack of women, in different parts of the workplace can limit productivity and the economy.[1] This is not just due to a lack of hours worked, but a lack of their insights, their imagination and their skills. The comparative absence of women in many of the technical arenas in which growth is expected – green energy and the energy transition, quantum computing and digital for instance – is striking, as is the lack of female-founder start-ups and scale-ups. As a nation, the United Kingdom (UK) does not do well at encouraging women into these growth areas; as a nation we lose their potential innovations and impact on productivity.

The problems start early, particularly in the English schooling system where decisions about subject choices are made as early as age 14. By that age, girls have imbibed messages from the world around them suggesting that the 'hard' sciences – specifically physics – and maths are probably not for them. Thus, regardless of how well girls perform at GCSE, the choices thereafter typically mean there are low proportions of girls in A-Level classes in those subjects, the very subjects that are most important for many of the developing areas of innovation. The Institute of Physics has been studying the reasons behind the lack of girls taking A-Level Physics for many years, and has reported how the whole school ethos impacts on both boys and girls, having the effect of steering each into a narrow range of subjects: boys tend not to take English or Psychology, for instance, whereas girls are likely to avoid Physics post 16.[2] The lack of girls in the A-Level Physics cohort feeds into a lack of women entering the engineering and allied professions.

Thus, the problems impacting the diversity of the workforce across many key sectors start early in the school life of a child. But, thereafter structures in the workplace mean that even those women who start out, in manufacturing, perhaps, or as entrepreneurs, may find the barriers they face unattractive, with their views not listened to or their innovations unfunded. Living in a world in which a male view can appear to dominate in so many spheres at every level in a business means the low proportions of women who start out in these spheres may quit to find easier work environments, even if these are less well paid and less satisfying.

The upshot of this lack of diversity, often visible at the single organisation level, is a loss of innovation and a loss to the UK economy. Productivity and innovation are not enhanced by a monoculture. Over the past decade or two, many reports[3] have highlighted these issues, with calls for companies to change their practices to be more inclusive, for boards to become more diverse and for venture capitalists to invest in women's start-ups, but the dial is shifting only

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[1] See for example: Equality, Diversity and Inclusion in the Workplace 2023, Nigel Wright https://www.nigelwright.com/uk/equality-diversity-and-inclusion-in-the-workplace-report-2023

[2] Institute of Physics, Closing Doors, 2013 https://www.iop.org/sites/default/files/2019-03/closing-doors.pdf

[3] For example McKinsey, Diversity Matters Even More, 2024 https://www.mckinsey.com/featured-insights/diversity-and-inclusion/diversity-matters-even-more-the-case-for-holistic-impact#/; Financial Reporting Council, 2021, Diverse Boards lead to Better Corporate Culture and Performance, https://www.frc.org.uk/news-and-events/news/2021/07/diverse-boards-lead-to-better-corporate-culture-and-performance/

very slowly. Policies need to recognise that our society is not experienced in the same way by boys and girls, essentially, from birth, and that that this is detrimental to the economy.

An economist's view of the contribution of women to growth would start with the observation that the more hours women work in total rather than staying outside the paid workforce, that is to say more women in the workforce working longer hours, the greater their contribution. It follows from this position that a greater contribution to economic growth by women will ensue if employers are able to modify working practices to facilitate this, by making their terms of employment more amenable to flexible working and working from home, for instance, so that more women join the workforce.

Caring responsibilities have been shown to cause significant loss in productivity to both the individual and the employer, as has recently been quantified (for the United States (US)) by KPMG.[4] This line of argument has been thoroughly rehearsed in a 2023 TPI paper by Rubery et al.[5] On the one hand, the rise in the availability of flexible/part-time practices encourages women back into the workplace; however, on the other, for the individual it may provide only low-income and unsatisfactory employment, leading to them being stuck in financial insecurity. Thus, good though it may be for the nation for women to be working in paid employment at all, for the individual it seems the gap between pay and security between young men and women is only growing.[6]

However, the analysis looking simply at hours worked, only represents part of how women as part of a diverse workforce contribute to gains for the economy. In this policy brief a range of different aspects are explored, showing how there is far more to the importance of diversity in driving innovation and productivity. In turn, the following will be considered: productivity impact of diversity; the tech industry; diversity in leadership; femtech, female entrepreneurs and venture capital; manufacturing, and wider skills shortages; women's health and productivity. This brief concludes with a range of policy recommendations, including education, employment practices, finance and entrepreneurship.

Productivity impact of diversity

Simply counting the number of hours women work omits any discussion of what work they are doing and what value, beyond simply the hours worked, they add to GDP and productivity in general. It is important to consider the wider contribution of women (and other under-represented groups, for whom many of the same arguments apply) to the economy, recognising that one worker is not necessarily the same as another, nor are hours worked a complete

[4] The parental work disruption index: A new measure of the childcare crisis, KPMG https://kpmg.com/us/en/articles/2024/september-2024-the-parental-work-disruption-index.html#footnote

[5] J. Rubery, I. Bi, A. Rafferty (2023) Gender and Productivity. Working Paper No. 032, The Productivity Institute https://www.productivity.ac.uk/wp-content/uploads/2023/03/WP032-Gender-and-productivity-FINAL-070323.pdf

[6] Gender pay gap in the UK: 2023, ONS release 1-11-23 https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/bulletins/genderpaygapintheuk/2023#:~:text=The%20gender%20pay%20gap%20increased,from%202.3%25%20to%204.7%25.

measure of the contribution to productivity. As The Productivity Institute identified in its Productivity Agenda (2023), one of the three key challenges facing the UK is the *inadequate diffusion of productivity-enhancing practices between firms and places*.[7] It is important to identify what contributions diversity can, does and should make to this challenge.

Although the link between research and development (R&D) and productivity is not straightforward, it is nevertheless the case that R&D plays an important part in driving economic growth and productivity, although it also depends on what kind of R&D is being done and where. Diversity plays an important role here, in other words *who* is doing the research matters. A 2020 report in the scientific journal *Proceedings of the National Academy of Sciences* (PNAS) highlighted that underrepresented groups, such as women and ethnic minorities, produced higher rates of scientific novelty than their majority counterparts. However, their novel contributions were more likely to be devalued and discounted.[8] Novelty typically sits at the heart of innovation, so that this failure to value their work means a loss to science and subsequent innovation.

Why might under-represented groups contribute so significantly to innovation? The life experiences of people in these groups typically differ from the (white male in general) majority, and hence they may view any particular problem from a different perspective, leading to new ways of thinking. Cognitive diversity is known to improve problem solving.[9] However, if leadership does not appreciate the work of such people adequately, these new approaches can vanish or never be sufficiently followed up to turn into innovative ideas and ultimately novel products. Furthermore, the actions of leadership in ignoring potentially valuable contributions may have the additional effect of driving minorities out of the scientific and technological workplace to somewhere where they feel their contributions may be better appreciated. So, there is potentially a double loss, both in the ideas and the people. As throughout this report, a lack of diversity in the workforce leads to a reduction in innovation and productivity, with original ideas never being worked up as their potential indicates they should be.

The tech sector

One of the sectors which is currently growing fastest, and where there is hope for significant future productivity gains, is the Tech Sector. The latest technologies in artificial intelligence (AI) and digital are expected to contribute to productivity across the whole economy, as new applications are developed and diffused. But this is a sector which has significant problems around diversity, and it is doing this in ways that are potentially extremely damaging for wider society. It is common to hear terms such as 'Tech Bro' being used, with its implicit maleness given away by the use of the shorthand 'Bro'. But, as AI and machine learning grow in importance across all sectors of the economy, that the training sets are typically selected by

[7] D. Coyle, B. van Ark, J. Pendrill (2023) The Productivity Agenda. Report No. 001. The Productivity Institute
[8] The Diversity–Innovation Paradox in Science: B. Hofstra, V. V. Kulkarnib , S. Munoz-Najar Galveza , B. He, D. Jurafsky and D. A. McFarland, https://www.pnas.org/doi/pdf/10.1073/pnas.1915378117
[9] S. Page *The Difference,* Princeton University Press 2007

men and the data are likely to contain all the current biases against minorities, simply means existing trends of excluding minority viewpoints and their data will be persistently amplified.

As long ago as 2019, Nesta produced a report on gender diversity in AI research.[10] They highlighted the lack of women in the field, and that in areas specifically relating to computing, the numbers had stagnated whereas they had grown in other sub-fields. It also showed that where women were co-authors of papers, the emphasis tended to be different from when male-only authors were involved, demonstrating how diversity impacts on research questions (and hence answers and solutions), as well as practice in the workplace.

For instance, a recent study on AI-based recruitment processes, highlighted both that algorithmic bias stems from limited raw data sets and from biased algorithm designers. In other words, both the underlying data used and the individuals involved in designing the algorithms utilised, introduced bias likely to harm minorities (and of course, not just by gender but by other characteristics too, including skin colour).[11] Too often algorithms amount to a black box, so that it is extremely difficult for those using them to know how biased or unbiased they may be. Consequently, individuals using them may be unaware of the underlying problems and their ethical implications.

With AI's increasing permeation of sectors and methodologies, this problem is becoming ever more acute. Using healthcare as a specific and important example, there is increasing recognition of the danger of bias creeping in to algorithms when it comes to healthcare decision-making and medical diagnosis, leading to unfair outcomes and the perpetuation of existing inequalities.[12] Despite the recognition of the problem, the lack of appropriate and unbiased datasets is a fundamental limitation, reinforcing the dangers of not having funded healthcare studies in ways that are themselves unbiased (as will be discussed below). In other words, if AI is to be used across the board, much more attention needs to be paid to ensuring that input datasets are not biased if the outcomes are to be fair and appropriately representative. To address such bias requires a holistic approach ensuring there are diverse and comprehensive datasets, as well as enhanced transparency and accountability in the AI systems themselves.

Healthcare provides a specific example of where obvious biases lead to poor outcomes, but the problems extend over every sphere where AI is penetrating, which by now represents just about every sector. Business leaders need to be aware of the issues and recognise that diverse teams at every level in a company are more likely to be sensitive to the potential dangers of using AI simply as a black box. This is not only about fairness, of course, but also will mean that

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[10] K. Stathoulopoulos and J. Mateos-Garcia, Gender diversity in AI research, Nesta 2019 https://media.nesta.org.uk/documents/Gender_Diversity_in_AI_Research.pdf

[11] Z. Chen, Z. Ethics and discrimination in artificial intelligence-enabled recruitment practices. *Humanit Soc Sci Commun* 10, 567 (2023). https://doi.org/10.1057/s41599-023-02079-x

[12] E. Ferrara Fairness and Bias in Artificial Intelligence: A Brief Survey of Sources, Impacts, and Mitigation Strategies *Sci* 2024, *6*(1), 3; https://doi.org/10.3390/sci6010003

segments of a market will not simply be ignored because they always have been historically, or that innovation opportunities are missed by relying on biased data. It is a long time since the Harvard Business Review clearly set out six actions business leaders could take to reduce and mitigate AI in their companies, including running algorithms alongside human decision-makers and explore how humans and machines can work together to mitigate bias, but the problems have only grown since that analysis in 2019.[13]

Diversity in leadership and management

Leadership drives so much; good leadership makes an enormous difference to teams, to profits and to company survival. Diversity in leadership, as well as in the workforce, means novel markets may be identified as well as novel products. A 2020 McKinsey report stated categorically that, from their analysis, '*The most diverse companies are now more likely than ever to outperform less diverse peers on profitability*.'[14] Yet many businesses do not seem to have learned this lesson. By comparing the 2020 data with that gathered in 2014, the McKinsey report found that the majority of companies had either made no progress or even slipped back. This applied in the context of ethnic diversity just as much as around gender diversity; and it applies in many countries.

Of course, profitability is not the same as productivity nor innovation, but the three are closely linked. Looking more specifically at innovation, a Spanish study showed how gender diversity within R&D teams generates certain dynamics that foster novel solutions leading to radical innovation.[15] Such innovation is exactly what will drive changes in practice and product, leading to increased productivity. In other words, ignoring diversity on any of these fronts is likely to hit both profits and productivity.

To take a specific if trivial example, presumptions about what women want in their clothes (as opposed to what men think women want to wear or what they'd like them to wear), means that women's demands for pockets in their clothes, have not yet translated into changing their design. The impact on productivity may not have been quantified but, it indicates a gap between what the marketplace, at least the female marketplace where so many decisions about spending (particularly in clothing as in other household staples) are made. This example highlights the importance of leadership and management teams that understand why diversity matters, both for productivity and their company's profits.

It exemplifies the case that many of the developments that would make a difference to women's lives are systematically ignored by those who could make that difference. Women complain about this regularly, but few manufacturers take their complaints seriously. However, as Cristina Criado Perez points out in her book *Invisible Women*[16] this has significant implications for

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[13] J. Manyika, J. Silberg and B. Presten, *What Do We Do About the Biases in AI?* https://hbr.org/2019/10/what-do-we-do-about-the-biases-in-ai

[14] Mckinsey Report Diversity Wins: How inclusion matters 2020 https://www.mckinsey.com/featured-insights/diversity-and-inclusion/diversity-wins-how-inclusion-matters#/

[15] C. Díaz-García, A. González -Moreno and F.J. Sáez -Martínez, Gender diversity within R&D teams: Its impact on radicalness of innovation. Innovation: Management, policy & practice (2013) 15: 149–160

[16] Cristina Criado Perez, *Invisible Women* Chatto and Windus 2019, p179

women's work, as well as how workers of any gender may interact with women, for instance around healthcare. Without pockets, women cannot carry smartphones around with them easily. Having them in a bag that they are not necessarily able to hold on to all of the time means women may miss vital calls telling them what to do next or where to be (if they are a worker) or enabling them easily to make calls about their health and wellbeing (if a recipient of care).

The consequence of this, from the perspective of productivity, is that women workers are disadvantaged in various sectors due to their lack of easy contact via a phone, leading to a loss of their own productivity, despite the women themselves calling for clothes to be routinely supplied with pockets and, furthermore, pockets large enough to accommodate the ever-increasing size of today's phones. It also means that women, often ill or poor women, cannot take advantage of modern technology to improve their care if a phone is not easily accessible to them but, say, on the other side of the room. As a further consequence of this, women may be forced to stay out of the workforce because of ill health, which then reduces hours worked, again hitting productivity. That is just one small example of where women's views are ignored, leading to a negative impact on aspects of women's productivity, because a predominantly male leadership culture doesn't see the other side of the coin in the way it impacts women.

Femtech, female entrepreneurs and venture capital

There is plenty of evidence to demonstrate that female entrepreneurs face a difficult landscape when it comes to getting their ideas and businesses to market. In 2019, the British Business Bank reported that for every £1 of venture capital (VC) investment in the UK, all-female founder teams received less than 1p, in contrast to all-male founder teams, who got 89p, and mixed-gender teams 10p.[17] The report noted that, although women are receiving an increased share of VC funding, their estimate was that it would take until 2045 for all-female teams to reach even 10% of all deals. Given the arguments presented here about how diversity leads to innovation, new knowledge and new markets, this is a dismal finding. These findings are similar to those found in the Rose Review.[18] Indeed, a recent study by the Invest in Women Taskforce suggests female founders are now faring even worse than previously, down from 2.5% to a mere 2% over the past year.[19]

Once again, lack of diversity means that the UK economy is missing out. According to the Rose Review, £250 billion of new value could be added to the UK economy if women started and scaled new businesses at the same rate as UK men. Even with a more modest aspiration of matching best-in-class comparator countries, if the UK were to achieve the same average share of women entrepreneurs, this would add £200 billion to the UK economy. A guide from the British Business Bank directed at would-be female entrepreneurs, highlighted the biases of

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[17] UK and VC Founders Report 2019, https://www.british-business-bank.co.uk/about/research-and-publications/uk-vc-female-founders-report

[18] The Alison Rose Review of Female Entrepreneurship 2019, https://assets.publishing.service.gov.uk/media/5c8147e2e5274a2a595bb24a/RoseReview_Digital_FINAL.PDF

[19] Hannah Barnard, Financial Times 20-3-25, *Female-led start-ups are increasingly starved of funding* https://www.ft.com/content/8dd0481b-da01-4b2e-af31-99efc689dad7?desktop=true&segmentId=7c8f09b9-9b61-4fbb-9430-9208a9e233c8#myft:notification:daily-email:content

society that may make it so hard for them to obtain money from the VC sector. However, it also strayed into victim-blaming when identifying some of the problems women have to cope with, including impostor syndrome and caring about work-life balance.[20]

This lack of access to funds for female entrepreneurs is something the European Business Bank has taken seriously, with one of their Vice Presidents, Lilyana Pavolova, spelling out in a 2020 report that '*Bankers and investors increasingly see that it is not only ethically and socially the right thing to do, but also a clear-cut case of smart economics. In other words, it makes economic and business sense to ensure that women entrepreneurs gain access to the same opportunities for success as their male counterparts. This is particularly the case for the technology and innovation space where women face pronounced barriers when it comes to creating and funding their businesses.'*[21] However, in the UK in 2024, women entrepreneurs continue to report the same problems: hurdles to obtaining funding and lack of access to appropriate resources and networks.[22] The consequence of this is a loss of innovative products as women entrepreneurs struggle to take their ideas to market.

Manufacturing and wider skills shortages

As the Royal Society highlighted in their 2022 report on Regional Absorptive Capacity[23], skills contribute to economic growth through increased productivity, but they are also crucial in the role they play in enabling innovation, something that is implicit throughout this report. One aspect of this is the way that skills enable innovation by increasing an organisation's absorptive capacity. In other words, making an organisation better able to understand and apply new ideas or practices within their workplace as these ideas diffuse across a sector or region. New ideas may lead to better and more efficient processes as well as novel products. This Royal Society report also showed that between 2010 and 2020, the largest growth in jobs across the UK was to be found in the professional, scientific and technical activities sector, particularly at degree level or above, but in many parts of the country, firms found problems in recruiting people to fill vacancies, something that is regularly reported by many organisations and something the government is well aware of.

In 2023, Jonathan Berry, then a minister in the Department for Science, Innovation and Technology, commented to the House of Lords that although there were roughly one million people working in R&D roles in the UK, due to retirement and the growing need for researchers

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[20] Overcoming challenges female entrepreneurs face , British Business Bank https://www.british-business-bank.co.uk/business-guidance/guidance-articles/business-essentials/overcoming-challenges-female-entrepreneurs-face

[21] Funding women entrepreneurs: How to empower growth, European Investment Bank 2020 https://library.oapen.org/bitstream/handle/20.500.12657/47425/QH0219470ENN.en.pdf?sequence=1

[22] Female Entrepreneurship: Moving Forward, Small Business Britain 2024 https://smallbusinessbritain.uk/downloads/female-entrepreneurship/Small-Business-Britain-Female-Entrepreneurship-Sep-2024.pdf

[23] Regional Absorptive Capacity: The Skills Dimension, Royal Society 2022 https://royalsociety.org/-/media/policy/publications/2022/absorptive-capacity-report.pdf

"that number will have to increase by around 380,000" by 2027.[24] That only refers to researchers, which is a small proportion of the jobs where skills in STEM (Science, Technology, Engineering and Mathematics) are needed. Turning specifically to manufacturing, a crucial part of the UK's productivity landscape, the latest Business Barometer Report highlights that this is the sector facing the most severe skills shortages, with 74% of businesses reporting problems in filling vacancies.[25] Many of these jobs will be those requiring STEM qualifications at different levels. Drilling down further into the statistics shows that the percentage of graduates in engineering, manufacturing and construction in the UK was only 9.1%, which is significantly lower than comparator countries such as Italy, Switzerland, Japan, Korea and Germany, where the percentage may exceed 20%.[26] Thus, manufacturing has a particular problem in recruitment.

When looking at the aggregate of people with STEM degrees, the UK has a much higher proportion of graduates with degrees in health and life sciences than in other countries. This proportion also reflects the fact that these are typically the courses women currently take, while relatively low proportions of women take engineering or physics – or indeed computing or information technology (IT) courses enabling them easily to enter the Tech sector. Thus, one way of plugging the skills shortage would be to create a culture in which girls opt for these subjects in greater numbers at school and in degree choices, and are supported in their subsequent careers when they do so.

A 2024 study by the Women in Manufacturing Group has looked at what experiences are like for women in these workplaces and what more needs to be done to keep them there.[27] It uses case studies to highlight the importance of a framework for promoting equality, diversity, and inclusion within the industry, applicable to businesses of all sizes, and types. As throughout this paper, it is clear how the lack of and loss of women from the workforce is damaging for the economy, meaning a shortage of skilled labour to fill the roles needed.

Women's health and productivity

Underlying any analysis of the hours that women work should be why they don't work. Such an analysis would be likely to include the unattractive options available in any area which can fit around the (typically) female role of caring in the home, be it for children or the elderly. How working from home impacts on productivity is a complex topic, and one which needs substantial disaggregation: some roles facilitate homeworking, typically the higher paid and higher skilled jobs, as opposed to sectors such as retail, hospitality or the care sector where attendance at the place of work is necessary. Contrasting conclusions about the impact of working from home

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[24] Quoted in Research Professional September 15 2023, https://www.researchprofessionalnews.com/rr-news-uk-politics-parliament-2023-9-minister-says-uk-needs-380-000-new-researchers-by-2027/

[25] Business Barometer June 2024 https://www.britishchambers.org.uk/wp-content/uploads/2024/06/The_Open_University_Business_Barometer_2024.pdf

[26] Cambridge Industrial Innovation Policy Becoming a technology superpower: is the UK producing enough scientists? https://www.ciip.group.cam.ac.uk/reports-and-articles/becoming-a-technology-superpower-is-the-uk-producing-enough-scientists/

[27] Women in UK Manufacturing 2024: Addressing labour shortages and bridging the gender gap https://www.ciip.group.cam.ac.uk/reports-and-articles/women-in-manufacturing-report-2024/

(WFH) can be seen, for instance by comparing the results of two papers looking at different populations and sectors. A paper in Nature claimed WFH improved retention without impacting productivity (based on a study in a tech firm[28]) is in contrast to a wider ranging study which implied (from a survey of managers, although not the workers themselves) that productivity had fallen as a result of homeworking.[29] It is a nuanced and complex question which I will not explore further here, but it is likely only to grow in importance.

There are other less immediately obvious reasons why a woman may not work (I am excluding the whole issue of maternity and caring here, because these are well-covered and much discussed elsewhere). In terms of less obvious but crucially important issues connected with diversity, one important area relates to substantive issues around health. There are many instances of diseases which impact only one sex, ranging from different cancers (for example ovarian and prostate cancer, the first only affecting women, the latter only men) to a wide range of other conditions. However, the evidence shows that conditions impacting women's health alone are less likely to be studied in depth, either than those affecting men, or diseases that hit both sexes equally. Endometriosis, for example, is a condition that can cause severe pain but has been comparatively little studied by medical researchers. A 2017 study from the US showed that there was a significant relationship between the severity of endometriosis symptoms experienced and the amount of working time and productivity lost as a result.[30]

However, the bias in what is considered to merit study – and funding – by clinical researchers, means that endometriosis receives little attention. A 2023 infographic in Nature graphically highlights how a range of conditions which only affect women, including endometriosis, are substantially underfunded relative to other conditions, despite the economic burden arising from affected women's absence from the workforce in terms of long term ill health, disability and even death.[31] Evidence from the US shows that the US funding agency, National Institutes of Health (NIH), has applied resources to diseases that affect primarily men, at the expense of those that affect primarily women.[32] (This is likely to be significantly worsened in the US under the current government.) Although a similar analysis has not been done for UK funders, it is hard to imagine the situation is radically different in this country. Thus, the bias in medical research is one contributory factor which impacts directly on women's productivity, since non-life-threatening conditions such as endometriosis (and also migraine, which is known to affect more women than men) remain chronically underfunded but lead to the loss of many days of

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[28] Bloom, N., Han, R. & Liang, J. Hybrid working from home improves retention without damaging performance. *Nature* **630**, 920–925 (2024). https://doi.org/10.1038/s41586-024-07500-2

[29] J.M. Barrero, N. Bloom, and S.J. Davis, The Evolution of Working from Home, Stanford Institute for Economic Policy Research, Working Paper No. 23-19, July 2023, https://drive.google.com/file/d/1kqbngD8pemqxAkZmWCOQ32Yk6PXK9eVA/view?pli=1

[30] A.M. Soliman, K.S. Coyne, K.S. Gries, J. Castelli-Haley, M.C. Snabes and E.S. Surrey. The Effect of Endometriosis Symptoms on Absenteeism and Presenteeism in the Workplace and at Home. J Manag Care Spec Pharm. 2017:745-754. doi: 10.18553/jmcp.2017.23.7.745. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10398072/

[31] K. Smith The funding gender gap Nature 617 May 2023 https://www.nature.com/immersive/d41586-023-01475-2/assets/d41586-023-01475-2.pdf

[32] A.A. Mirin Gender Disparity in the Funding of Diseases by the U.S. National Institutes of Health. J Women's Health (Larchmt). 2021 30:956-963. doi: 10.1089/jwh.2020.8682.

productive labour. The same is true of lethal diseases such as gynaecological cancers, compared to other forms of cancer, where the amount invested in research does not relate to lethality.

Policy implications

The different aspects of gender-related contributions to productivity require different solutions but, underlying much of what is written above, is that young girls and teenagers making choices about their career aspirations opt out of technical areas. A key part of ensuring we have sufficient engineers, technicians and female founders, for example, of femtech companies, is that we improve the educational offer so that girls are not deterred from starting on these career paths. Any policy recommendations must therefore start with what happens in a child's early years.

Early years education

Currently little attention is paid during teacher training (either for nursery or later years' teachers) to the issue of gender stereotypes in general, and around STEM in particular, or how these should be countered. Teachers should aim to negate cultural messages about girls' behaviours (e.g., risk-taking to encourage entrepreneurial skills) and presumed aptitudes in subjects such as Maths or Science. A short segment to cover this issue in teacher training courses – both for primary and secondary school teachers, as well as nursery staff – should become mandatory, so that teachers are both aware of and prepared to challenge stereotypes, whether in the behaviour of the children themselves or how they talk about wider society. The national curriculum should be expanded to include more examples of scientists who are not white men, so that *every* child is confident that STEM is for people like them, if they wish to follow that path. Inclusion sits at the heart of the current government's Opportunity Mission and needs to be translated into teacher training. Such changes would not just benefit girls, but cultural stereotypes affect boys too and can be just as bad for them – although in different ways – as a recent report by the Higher Education Policy Institute (HEPI) has made clear. [33] More attention needs to be paid to gender in the classroom to overcome the subliminal messages about what is 'right' for boys and girls to say and do throughout their young lives.

Ofsted also plays a part in establishing whether the whole school ethos is genuinely inclusive and whether there is active work being done to counter stereotypes. At secondary schools, one easy measure to look at would be the number of girls and black children progressing to A-Level Physics and likewise the number of boys pursuing English or Modern Languages. These would all provide proxy measurements for how successful a school is in providing an environment in which children do not feel limited in their choices by societally imposed views.

[33] Nick Hillman and Mark Brooke, HEPI Report 188, Boys will be boys: The educational underachievement of boys and young men https://www.hepi.ac.uk/wp-content/uploads/2025/03/Boys-will-be-boys-The-educational-underachievement-of-boys-and-young-men.pdf

Careers advice needs to be improved, at least to the level of the Gatsby benchmarks[34], so that every child has access to information about a wide range of careers. Subjects, such as Engineering, which are not formally taught within the curriculum, need to be discussed, ideally with professionals coming into the school to talk about their jobs. Additional financial support for such school visits, whether directly organised through the local authority or through organisations such as Speakers for Schools, is needed at a relatively modest level.

Careers advice must also support all those who, post-16, wish to pursue a technical rather than academic route. T-Levels were meant to provide for this cohort, but have not yet proved their worth, and the gender divide in subject choice is as obvious here as in A-Levels.[35] Currently Skills England is in its (shadow) infancy, but will have a key role to play in making sure there is coherence across the system for those who wish to move between different parts, or who are initially uncertain about where their specific focus should be. Coherence will only come to pass if different parts of the educational ecosystem are not competing with each other for funding, as too often happens currently[36]. This situation urgently needs attention.

There are various third sector and charity organisations which aim to spread the word about women's place being in the STEM sectors. Providing small amounts of funding to support such organisations, ranging from Girl Guiding (with its graded badge for 'Innovation' aimed at different age groups) to Girls who Code, Soapbox Science and Stemettes, could expand their reach at modest cost, to inspire children and teenagers to expand their horizons beyond outdated stereotypes.

Diversity in leadership, management and the wider workforce

There are many examples of businesses, large and small, which have taken diversity and inclusion seriously on board, and can demonstrate the benefits to their company and their customers. Showcasing these businesses, both their policies and their outcomes, will help to motivate others to follow suit. A diversity award for businesses that successfully transform their activities (mirroring, for instance, the King's Award for Enterprise) would demonstrate that the government takes these matters seriously when it comes to growth and the economy. There are many examples of actions other organisations have taken to show commitment to the matter, ranging from the generic United Nation's 'He for She Champions' to Statista's listing of 'Europe's Diversity Leaders', published each year and the government could learn from these.

Businesses that already have this matter on the management's minds, will no doubt also be aware of the pipeline shortages. For them, there are two paths that could be taken to improve matters. Firstly, ensure their employees – male or female – are going into schools to deliver messages about what STEM and technical careers are like and why students ought to consider them, as noted above. Secondly, through every interaction they have with youngsters (work

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[34] Gatsby Foundation https://www.gatsby.org.uk/education/focus-areas/good-career-guidance

[35] A Patel Results 2024: 7 key trends from VTQ and T Level results, FE Week 15th August 2024 https://feweek.co.uk/results-2024-7-key-trends-from-vtq-and-t-level-results/

[36] Dave Phoenix, Connecting the Dots, HEPI report 167, 2023, https://www.hepi.ac.uk/wp-content/uploads/2023/11/Connecting-the-Dots.pdf

experience, T-Levels, apprenticeships as well as recruitment) expect and facilitate as many girls and women to access these as men. By not cementing expectations that girls will head into clerical roles and boys into engineering at the outset (e.g., through work experience), expectations in the school population will change, leading to a change in the mix of employees down the line.

Groupings such as WISE and Women in Manufacturing do excellent work on a shoestring. Additional, if modest, funding to allow them to reach further into business to offer support and mentorship for the women who have started along this career path and to advise SME's how to recruit and upskill a diverse workforce should be assigned. Professional bodies are increasingly aware of the challenges, but prizes to highlight their work (such as the Royal Society's Athena Prize[37]) are privately supported. Government should step in to champion what is being done and what more could be done to demonstrate the value placed on diversity and inclusion (as seen, for example, through retention rates) in the workplace. Kitemarks or other measures of esteem cost little beyond administrative costs but can be a powerful tool to incentivise organisations to act.

AI and the tech industry

The problems facing the industry are global in scope, but will impact locally as well as internationally. Currently the situation is worsening due to the US government's new attitude towards diversity, equity and inclusion (DEI) initiatives, meaning US-based companies are likely actively to head in a regressive direction. More pressure needs to be put on the large, multinational tech companies from this side of the Atlantic (Europe including the UK, for instance, acting collectively) to do better at removing bias from their products. This is a problem that cannot be overstated, as the hidden implications and cost will persist in ways that are likely to be invisible to the general public but persist in a vicious cycle. As the evidence shows, there are potential detriments across the board, including (but not limited to) women's healthcare, cultural messaging and decision-making at recruitment and progression. Both racism and misogyny are hidden within many an algorithm. A government committed to opportunity for all, as one of its key missions, needs to grapple with this problem which absolutely can act against this mission statement.

Serious work needs to be done by any organisation implementing AI in its products or analysis to mitigate this issue. This is an area where (in some cases international) regulation is required to ensure unbiased dataset frameworks and improved algorithmic transparency, as well as management measures like internal corporate ethical governance and external oversight. For major parts of the UK economy, such as the National Health Service (NHS), government must insist on a systematic introduction of processes that knowingly avoid bias in decision-making, be it for who gets which drug or the use of diagnostic techniques supporting medical teams. If the UK wants to remain at the forefront of AI development, it is crucial that government seeks to introduce regulatory measures that reduce bias in AI products and their implementation.

[37] Royal Society https://royalsociety.org/medals-and-prizes/athena-prize/

Femtech, female entrepreneurs and venture capital

It is unclear whether venture capital firms are aware of the imbalance in their funded portfolios by gender. Is the bias conscious or unconscious? The belief that women are less likely to take risks is prevalent but not well founded; research shows that it is not the risk-taking itself that deters women, but the backlash they may experience if they step out of what is seen as 'normal' women's behaviour.[38] However, this belief may have the effect of deterring funders from 'taking a punt' by apparently reinforcing the myth. The BBC's programme, Dragon's Den, illustrates the typical imbalance in funding rounds, although women like Steve (Stephanie) Shirley have long been able to demonstrate that success in setting up STEM-based businesses is not solely a male preserve. Following the Rose Review, the Council for Investing in Female Entrepreneurs was set up as a voluntary collective, independent of government, which runs the Invest in Women Hub as a resource for women seeking to raise capital.

That is a start but there is more to be done to implement the full recommendations from the Rose Review. One area in which there is clear growth is in so-called femtech companies, companies which focus on technology-driven products, services, and software specifically designed to address women's health and wellness needs, typically headed up by women who spot the need and the niche for them. As indicated earlier, this is a segment of research and innovation that receives less attention than it deserves and needs in conventional companies led (typically) by men. Data shows that slightly over 50% femtech companies are fully female-founded.[39] This figure should be compared with other sectors, where only 6% of high-growth UK companies are fully female founded.

Given that venture capitalists themselves are predominantly men, it may be desirable to start introducing policies that act as a stick to facilitate investment in women-led companies. The Rose Review recommended the creation of an Investing in Female Entrepreneurs Code, committing all financial institutions to the principles of gender equality and transparent reporting of gender funding data. This code is still needed. It also recommended a degree of ring-fencing of funds in ways that would help female entrepreneurs. This could, for instance, be around femtech or broad environmental, social and governance (ESG) areas. Creating a virtuous circle of successful female entrepreneurs who can inspire (and mentor) a future generation of women to enter this sphere will provide long term benefits.

The European Union has long had a prize for female entrepreneurs (which is also open to associated countries such as the United Kingdom (UK)) who have already made significant contributions, as well as for rising stars.[40] These awards are explicitly offered to showcase the success of women, and celebrated with a big and well-attended event in Brussels which

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[38] T. Morgenroth, M.K. Ryan, and C. Fine, C. (2022). The Gendered Consequences of Risk-Taking at Work: Are Women Averse to Risk or to Poor Consequences? Psychology of Women Quarterly, 46, 257-277. https://doi.org/10.1177/03616843221084048

[39] Lily Ruuah, Beauhurst, High-Growth Femtech Companies UK | 2024 https://www.beauhurst.com/blog/top-high-growth-femtech-companies-uk/

[40] European Prize for Women Innovators https://eic.ec.europa.eu/eic-prizes/european-prize-women-innovators-powered-eic-eit_en#ref-2022-edition

receives significant media attention and could be replicated within a UK context (as with the Queen Elizabeth Prize for Engineering). Innovate UK has chosen to create specific, if small, awards to support women founders, which provide some cash, as well as bespoke business support.[41] However, the sums involved – up to fifty awards of £75,000 each – are probably insufficient to bridge the gap between the idea and a product. By raising the size of the award, and by working with venture capitalists to match funding, the attitude that women entrepreneurs aren't worthy of support could be altered in a healthy way, using government funding and leverage to facilitate a growth in female entrepreneurs.

Manufacturing and skills shortages

Companies in the UK are being held back by skills shortages in the STEM arena, so under-utilising half the population makes no sense. Skills England is being set up to try to bring coherence to the post-compulsory education landscape, but some of the problems could be mitigated by focussing additionally on adult upskilling, particularly in the digital arena. The money put into adult upskilling, by firms or by government, has dropped substantially over the past decade or two. Returnerships and bootcamps, introduced by the last government, do not (yet) seem to have been successful, according to latest figures released under a Freedom of Information (FOI) request. [42] As FE Week says, they 'suggest high numbers of participants fail to complete their course or gain employment'.[43] Nothing in them has been specifically targeted at women who may have been steered away from computing and information, communications and technology (ICT) at school by gender stereotyping, so a targeted programme that was reworked, operating under Further Education or Higher Education controls, rather than through commercial providers, could be an efficient route to solving some of the skills shortages.

Additionally, women already working in companies could be assisted to up- or re-skill through in-house programmes. Incentives should be introduced – for instance in the ways the revised Growth and Skills Levy can be used – to encourage minorities including women to progress. The evidence shows that these groups are frequently overlooked when it comes to opportunities for training (due to outdated cultural attitudes), or find that inflexible training programmes make them impossible to access due to their caring commitments (of course, this will apply to and benefit some men too). Incentives to ensure that available training is both flexible and inclusive should be considered and also to ensure that businesses take advantage of what is on offer to support women and minorities.

Women's health and productivity

There is scope to mimic what the Gates Foundation has done for so-called neglected tropical diseases by setting aside government funding (e.g., UK Research and Innovation) specifically for under-researched issues impacting women's health. Research may be a global endeavour, but UKRI is not an insignificant funder which could highlight some of these diseases, such as

[41] Women in Innovation Award https://apply-for-innovation-funding.service.gov.uk/competition/1894/overview/68cc8452-3251-4a92-9019-006cc790ccf7
[42] https://www.whatdotheyknow.com/request/skills_bootcamps_number_spending
[43] FEWeek 24-5-24 https://feweek.co.uk/skills-bootcamp-results-missing-in-action/

endometriosis and other problems affecting only women, to encourage other organisations to follow suit. The economic burden of allowing these diseases to be under-researched and even ignored is significant.

Conclusion

Taken together, this suite of measures would lead to substantial progress in equity, and also lead to a healthier diversity of workers across the workforce. This would catalyse more innovation in fundamental research as well as in innovation within companies large and small, with consequential benefits for innovation, productivity and economic growth. Ignoring the benefits of diversity in terms of new ideas, new opportunities for female founder companies and better health for women wastes the potential of a substantial part of the working age population. Using their diverse talents more effectively is an obvious opportunity for higher productivity and economic growth.

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