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The impact of Brexit on the future of UK forensic science and technology

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ABSTRACT

This article seeks to assess the prospects of UK forensic science and technology in a post-Brexit world by analysing four interlocking issues: Brexit itself, the evolution of national criminal justice organisational and funding priorities, the increasing interrelationship of science and technology in the forensic domain and the relatively disadvantaged place of forensic science and technology within the contemporary 'scientific state' paradigm. The results are generally pessimistic for the likely future of forensic science. This conclusion is reinforced by scepticism about the wisdom of proceeding with Brexit. The article is structured to identify the potential implications of British political decisions on its national forensic science capabilities and capacity. Some aspects of the analysis are likely to have a wider resonance for international discourse about the future sustainability of forensic science and technology, however, particularly the interface between the globalisation of science and technology with justice.

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1. Introduction

'Brexit' – the process for the UK to leave the EU – will undoubtedly have major implications for British forensic science. Any forecast of the Brexit effect is necessarily for some time to come conjectural. It is possible, however, to identify the most significant consequences of Brexit for UK forensic science and to consider their implications alongside other developments that are already reshaping UK forensic science capabilities and capacity. The most noteworthy of these are scientifically and technologically led developments: the impact of digital and cyber forensic technologies, and the use of Artificial Intelligence (AI) in a forensic setting. These scientific and technological changes will have a considerable resonance for the future of forensic science beyond the UK. The societal mediation of such changes though will reflect national circumstances shaped by the general evolution of UK criminal justice organisational priorities and funding. Hence the importance of understanding the possible overall impact of Brexit on the UK criminal justice system. This could work in unexpected ways. For example, UK political and criminal justice professional ambitions to engage in forensic DNA data sharing after Brexit have resulted in the implementation of some (albeit limited) of the

long-postponed improvements in the forensic science quality standards regime within the UK.

Such an analysis would be incomplete without considering the roots of what – it is suggested in this article – is the comparatively disadvantageous place of forensic science and technology within science and technology policy making. Benner describes the contemporary 'scientific state' paradigm as the culmination of government policies that have socialized the costs and risks of corporate innovations 'to enhance the competitiveness of firms on global markets' and notes how higher education and research have been 'aligned with the existing and future interests of civil society and the economy' [1]:

'Knowledge has always been mobilized for political and economic purposes, but these purposes have now become explicitly articulated: research should reinforce and underpin the competitiveness of nations and other geographical entities, and firms and individuals within them; and policies should align the cognitive aspects of research with economic exchange' [2].

Science applied to assist criminal justice agencies, institutions and personnel in their quest for truth is naturally aligned with the needs of civil society, but less so (or at least not always) with economic exchange. In this respect reflection about national science and technology policy serves to introduce a cautionary note. This may give the analysis of the future UK forensic science and technology landscape in this article possible further international relevance.

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The scientific community is highly globalised (alternatively 'de-nationalised'), [3] whether through the scientific labour market, the organisation of major research projects, academic journals and EAFS2018 or equivalent scientific conferences. Yet scientific globalisation is never, as indicated above, an unmediated force. For any field of science to flourish it is likely to need to be in tune with its time. UK forensic science flourished to an extent never achieved before with the introduction of the DNA Expansion Policy (2000–2005). This policy was born from the conjunction of an existing government disposition to invest in genetic science with political intentions to be 'tough' on volume crime, including burglary [4,5]. Even at the time of this unprecedented investment in forensic science, however, there was powerful and repeated criticism of Government stewardship of forensic science. Successive Parliamentary reports [6] and official enquiries had far too little impact on government policy, especially over independent quality standards and access to the scientific support for defence lawyers that is so essential in the UK adversarial legal system [7]. As UK science policy has become increasingly preoccupied with national competitiveness, forensic science looks to become progressively disadvantaged compared with other scientific domains. This has now reached the point where the Forensic Science Regulator has expressed concern about existential risks [8,9].

In attempting to map the prospects of UK forensic science and technology in a post-Brexit world, this article examines the four interlocking issues described above. Two of these are UK-centric: (a) Brexit and (b) the evolution of national criminal justice organisational and funding priorities. The other two are likely to have international significance: (c) the increasing interrelationship of science and technology in the forensic domain and (d) the potentially disadvantaged place of forensic science and technology within the contemporary 'scientific state' paradigm. The analysis is developed from material examined in four sections. The first two sections emphasise the significance, respectively, of the nature of Brexit as a process that will take place over several years and the EU legal framework for criminal justice cooperation. A third section considers the short-term implications of Brexit. The fourth section deals with the medium-term prospects for UK forensic science and technology in a post-Brexit world.

The material in this article is mainly confined to England and Wales (hereafter England); the other two UK territorial jurisdictions of Scotland and Northern Ireland are different in many important respects, but in terms of scale and the interface between the UK and the EU, England and the UK are constitutionally synonymous and in practice from a cooperation perspective almost identical.

2. Brexit: a process and not a single event

Brexit is not a foregone conclusion: the UK is (at the time of writing) legally entitled to remain in the EU on its present exceptionally favourable membership terms, [10] but Brexit is more likely to happen than not. Also, Brexit is a process not a single event. In addition to leaving, the UK and EU need to agree the nature of their future relationship. The present uncertainty about when and how Brexit will happen, and also about the short- and medium-term consequences of Brexit could last for several years.

The process is legally determined by Article 50 TEU (The Treaty on European Union). This creates a framework that allows the UK and the EU to negotiate the terms of departure prior to the UK leaving (a withdrawal agreement), but does not permit a new long-term relationship to be agreed until after withdrawal.

Other than without a withdrawal agreement ('a no deal Brexit'), the UK's secession from the EU will result in a three phased process:

a) Withdrawal (at the time of writing no later than 31st October 2019) [11]: In addition to settling financial liabilities, the

withdrawal agreement is likely to bring into force a treaty relationship with both temporary (for example, criminal justice cooperation during this period) and indefinite obligations (especially to protect the position of EU 27 citizens resident in the UK ultimately with rights enforceable at the Court of Justice of the European Union (CJEU) and to prevent under any circumstances a 'hard border' in Ireland) [12].

- b) A transitional period for the negotiation of the future relationship. It has long been envisaged that this would expire on 31st December 2020, but the draft Withdrawal Agreement (draft WA) negotiated between the British Government and the EU allows for a single extension to be agreed before 1st July 2020, [13] should negotiations be likely to overrun the December deadline.
- c) The long-term relationship (currently envisaged to run from 2021 onwards): this UK-EU treaty will, among many other measures, determine the long-term criminal justice and scientific cooperation arrangements and, as will be explained in Section 4 below, for the UK the ultimate economic cost of Brexit. Only at this stage will the final implications, including those for forensic science and technology become clear.

The long-term relationship (in whatever form it takes and when) will be shaped by three major economic, political and historical issues. These are the foundations on which the EU and civil peace in Northern Ireland have been built: the Customs Union, the Single Market and, consistent with the Good Friday Agreement (GFA), the avoidance of a physical border between the Republic of Ireland and the UK. Resolving these big questions is likely to take several years and during this period future criminal justice and scientific research cooperation will be second order considerations.

3. EU criminal justice and scientific cooperation

In addition to analysing the direct consequences for UK forensic science of Brexit, this section also notes the extent to which political and professional ambitions to engage in forensic DNA and fingerprint data sharing have indirectly resulted in general benefits for forensic science standards within the UK.

The transformation from the Common Market to the EU was paralleled by the development of new and increasingly comprehensive arrangements to protect individuals (irrespective of national citizenship) in member states through increasingly faster and less costly criminal justice cooperation. This can be seen simply as 'positive spin-offs' from the economically driven evolution of the European project [14]. Global public goods (GPG) theory, however, more positively locates criminal justice, law enforcement or security cooperation centre stage in how governments and other institutions can work together to counter the negative spillovers of globalisation [15,16].

A 'No deal' Brexit would mean the abrupt termination of all criminal justice cooperation, including in many or all current proceedings still dependent on such assistance. In contrast the draft WA would freeze much of the present cooperation arrangements until at least 31st December 2020. Even in this more benign scenario there is likely to be a reduction in criminal justice cooperation (e.g. the draft WA allows EU member states to place significant restrictions on extradition to the UK and less participation in Europol information sharing). For reasons that are explained below, however, the transitional arrangements could prove to be better than what might become available under the future UK-EU relationship long-term agreement.

Many criminal justice professionals, therefore, may come to hope that the transition period will be extended as long as possible beyond 31st December 2020. For scientists the situation is

different. UK participation in EU research programmes expires with Horizon 2020. Unless the future relationship is negotiated relatively quickly British institutions may be ineligible to receive funding from 2021 onwards under the next research programme, Horizon Europe [17]. Given its dependence on criminal justice, the tension between such contradictory aspirations are likely to marginalise (or expose the existing marginalisation of) the influence of forensic scientists within UK science policy decision making circles. Though, as will be seen below, UK forensic science and technology would also benefit from speedy readmission on a third country (non-EU state) basis to EU research programmes.

The EU model for criminal justice cooperation on a continental scale is an unparalleled achievement. The existence of precedents for some aspects of the EU cooperation model between neighbouring states does not diminish the significance of this [18]. The model was born from a combination of high level political desire for EU wide action on international terrorism and illicit drug trading with earlier professional pragmatism within national policing in response to cross-border offending. It has been argued elsewhere that this has resulted in a transnational policing ethos (in contrast to 'international' or 'interstate' policing) with a significant decoupling of professional agenda-setting and practice from political scrutiny or judicial control [19]. While not accepting this view, it should be noted that tensions exist over the proper scope and constitutional validity of some aspects of EU criminal law [20]. The decoupling issue has been resolved to a great extent, however, by locating Europol and Eurojust (also member state judicial cooperation) in a system of EU political and judicial governance anchored in fundamental rights law. The approach underlying EU law governing criminal justice cooperation also generally defers to the relevant national law of the member states involved in any particular case. This can result in a sometimes complex relationship between different sets of national rules intended to ensure fairness in legal proceedings. Irrespective of whether tested against Article 6 of the European Convention on Human Rights (ECHR) or Article 47 of the Charter of Fundamental Rights of the European Union (CFREU), such cooperation is not always easy [21].

Forensic science and related disciplines such as fingerprint analysis have largely set their own professional agenda within this area of EU activity. To a great extent this has been driven by a truly international debate about the foundational validity etc. of individual disciplines and dramatic progress in genetic science, much of it powered by US policy development and research funding (both public and private) [22,23]. This strong degree of professional autonomy is reflected both in the original (1999–2004) personal membership of ENSFI – confined to the directors of forensic institutions not police forces or ministries to which they might be subordinate – and the organisation's formal monopoly status from 2009 onwards for forensic science within EC law enforcement development programmes [24]. This has worked well in the context of the Prüm system for sharing biometric forensic data. Not only has professional cooperation overcome match validity problems arising from the wide range of loci in various

national multiplex authorised by the legislation under which Prüm DNA profile sharing was initiated, [25,26] but this has also made possible global convergence of EU multiplex with the markers in US and Chinese systems [27]. This is illustrated in Table 1.

Table 1 is a reminder of two lessons for the UK from the recent history of European forensic science. First the UK benefitted considerably from the involvement of its now closed public sector forensic science institution, the FSS, in ENSFI and EC funded work to ensure overlap between different multiplex systems to make the international sharing of information between forensic DNA data more reliable. Second, while ultimately bioscience companies provided the multiplex kits, public sector scientific institutions were needed to either set or encourage a collaborative international agenda [29]. The significant risk of at least a temporary exile of UK institutions from EU research programmes during the transition period makes a decline in the global influence of UK forensic science and technology institutions likely. The degree of damage will depend on the time required to negotiate the new long-term relationship and the extent to which this would then allow the UK to participate on the model of other third countries (non-EU states, e.g. Switzerland). (This is, of course, contrary to the potential internal tensions over the length of the transition period described above that are likely to be encountered by forensic scientists within UK science policy decision making circles because of the formers' subordination to criminal justice policy makers).

Against the background of EU achievements, it is not surprising that there is an almost complete UK political consensus that the country should seek to continue to participate in security and criminal justice cooperation with the EU after Brexit. For example, one Parliamentary committee in March 2017 welcomed:

'the Government's signals that it intends to continue to cooperate with the EU on criminal justice. The seriousness of the matter and the degree of mutual interest give weight to the suggestion that this aspect of negotiations be separated firmly from others . . . it is too precious to be left vulnerable to tactical bargaining' [30].

Academically, however, there was very early recognition that the UK would no longer be able to (indeed, should not) continue, its Lisbon Treaty entrenched position to 'cherry pick' and maintain its current unbalancing participation in the ASFJ acquis [31]:

'[The] . . . exceptional status for the UK allowed it to benefit from a totally unusual pick and choose capacity, leading to risks of deep imbalances for the European criminal justice area. . . . Allowing some Member States to avoid a part of the acquis brings with it the risk of ending up with serious imbalances, compromising the establishment of a genuine European criminal justice area' [32]

'The price of the security benefits of EU cooperation will be full compliance with the EU acquis, including the acquis on the protection of fundamental rights: a paradoxical outcome with the UK having to accept more EU law than it currently does as an EU Member' [33].

Table 1
International Forensic DNA Multiplex Convergence [28].

	Multiplex	Number of national markers	Overlap between UK and US markers	Overlap between UK and Chinese markers
1995	UK SGM	7	N/A	N/A
1998	USA original CODIS	13	6	Unknown
1999	UK SGM+	11	8	Unknown
2010	China Sinofiler	15	N/A	9
2014	UK (England and Wales) DNA-17	17	8	10
2015	UK (Scotland) DNA-24	24	13	14
2017	USA CODIS core loci	20	15 (England and Wales) 20 (Scotland)	N/A

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These assessments are consistent with the realisation that the outcome for the UK of the exit process — as with the three major economic and political issues highlighted earlier in this paper — depends on ‘the kind of bargain the EU [is] willing to offer’ [34].

In turn the EU has little freedom to depart from the logical consequences of the treaties on which it (as a polity) is based and the inter-state relationships these have established:

There is a strong sense in Brussels that they cannot give the UK better treatment than they are giving to third countries that are part of Schengen [The UK] will need to have a procedure that . . . the [EU] considers to be fair and according to human rights. If the UK decides to pull out of [CFREU] that will pose a problem . . . That means that any extradition deal . . . will be constantly scrutinised, because the UK will no longer be part of the mutual trust system that allows member states to be so quick in exchanging information, people and so on [35].

Access to the SIS (Schengen Information System) II system that, *inter alia*, contains details of outstanding arrest warrants and terrorist suspects — not available to Denmark (despite its status within the EU and Schengen area) — but highly desirable for the UK is relevant in this context [36].

To some extent there appeared to have been progress (within the UK Government) during the withdrawal negotiations, with Prime Minister May acknowledging in February 2018 that, against an early anxiety in her premiership about a continued role for the Court of Justice of the European Union (CJEU) in UK criminal justice needed to be subordinate to continued UK-EU cooperation:

It must be respectful of the sovereignty of both the UK and the EU’s legal orders. So, for example, when participating in EU agencies the UK will respect the remit of the European Court of Justice [37].

In March 2018, Prime Minister May was even more explicit. She stated that ‘even after we have left the jurisdiction of the [CJEU], EU law and the decisions of the CJEU will continue to affect us’ [38].

Commission thinking does not appear to be strategically far apart from that of the British negotiators, envisaging a future criminal justice and security partnership based on four building blocks: effective exchange of information; support for operational cooperation between law enforcement authorities; judicial cooperation in criminal matters; and measures against money laundering and terrorism financing [39]. The European Parliament, however, has reminded the negotiators that after Brexit, the nature of UK participation in criminal justice cooperation will have to change significantly because third countries (outside the Schengen area) do not benefit from any privileged access to EU instruments, including databases, in this field. It expects separate arrangements . . . to be found with the UK as a third country as regards judicial cooperation in criminal matters, including on extradition and mutual legal assistance, instead of current arrangements such as

the European Arrest Warrant’ [40]. Whatever form the new relationship takes, it will need to be based on the ‘inextricable link between mutual trust, mutual recognition, respect for fundamental rights and membership of the EU (which includes the jurisdiction of the CJEU)’ [41].

It is impossible that such complex (legal and operational) and politically sensitive arrangements can be negotiated quickly after Brexit. The best outcome would be to preserve as much of the present arrangements as possible at the moment of Brexit, as is anticipated in the draft WA [42]. These temporary arrangements may then need to remain in force for several years beyond the envisaged period for transition (which could end as early as 31st December 2020), while a new security and criminal justice relationship is worked out. In the meantime the political and professional ambitions to engage in forensic DNA data sharing outlined above have indirectly resulted in a limited general benefit for forensic science standards within the UK. One of the problems that the Forensic Science Regulator’s quality standards regime has consistently faced has been the lack of statutory powers to require compliance with the standards. This changed in 2018 when secondary legislation was brought into force for mandatory standards compliance for all forensic DNA and fingerprint analysis work specifically to satisfy the rules of the Prüm data sharing regime. As the Forensic Science Regulator commented in her 2019 Annual Report:

Without a doubt it was the imminent legal requirement to gain accreditation, as a result of the Accreditation of Forensic Service Providers Regulations 2018, by which 2009/905/JHA is being transposed into UK law, that finally enabled progress to be made. This has clearly demonstrated that some organisations will only comply with standards when they are required to by law; a clearer case for statutory powers for the Regulator would be difficult to make [43].

4. The short-term implications of Brexit

The starting point for any consideration of the short-term implications of Brexit has to be its likely fiscal impact. There is a reasonably clear consensus between economists (including those based in the UK finance ministry, HM Treasury) that the more the UK moves away from the EU in terms of tariffs and Single Market rules, the greater the loss to its GDP and fiscal income. It has been estimated that by 2030 a ‘hard Brexit’ (major disengagement from the EU over tariffs and standards) would reduce cumulative GDP growth by 18% compared to a situation where the UK continued its EU membership. Closer future relationships would still cost 10–12.5% of cumulative growth over the same period [44]. An analysis of government data against four post-Brexit relationship options between the UK and the EU makes it possible to illustrate the impact of the consequential weekly net fiscal loss graphically (Fig. 1) as a percentage of current weekly public health care (NHS)

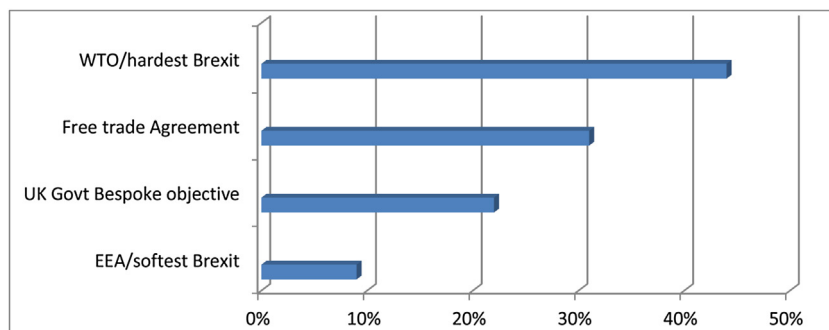


Fig. 1. The estimated weekly net fiscal loss to the UK Government resulting from Brexit presented as equivalent to current weekly NHS spending. Data sourced from J Portes, Putting a price on Brexit [48].

spending [45]. Despite the draft Withdrawal Agreement allowing for UK exit payments to be spread over a long period, with an estimated 75% being paid by 2022 (with the rest continuing until possibly the 2060s) [46], ‘there is likely to be virtually no “Brexit dividend” in [the short-term] . . . that could be diverted to fund public services.’ Any small net savings in EU contributions could be easily exceeded by higher UK administration costs resulting from Brexit, for example, on expanded border controls and immigration enforcement systems [47].

The worrying potential fiscal consequences of Brexit have to be considered against widespread problems in UK government services (both national and municipal) resulting from fiscal austerity (budget cuts). These were initiated in response to the 2008 financial crisis. The scale of public sector budget cuts has been masked to some extent by the erosion in real terms (i.e. allowing for inflation) of staff salaries, but the overall pattern, significance and managerial response for the purposes of this paper can be illustrated from the decline in police expenditure (the main source of forensic science and technology expenditure):

- Between 2010–11 and 2018–19 police forces in England and Wales experienced real-term reductions in funding ranging from 11% to 25%.
- The total number of employees in those forces fell by 18% (within that the number of police officers fell by 15%) between March 2010 and March 2018 [49].

The net effect of this on key outcomes in the criminal justice system and crime trends cannot be assessed with precision, but a 2018 Parliamentary report noted that:

‘Many ‘volume’ crimes, including robbery, theft from the person, and vehicle-related theft, are now increasing at an alarmingly steep rate, after a long period of decline. While recorded crimes have risen by 32% in the last three years, the number of charges or summonses has decreased by 26% and the number of arrests is also down’ [50].

Forensic science and technology work commissioned by the police, CPS and defence lawyers has been almost perpetually trapped within a cycle of declining funding and professional morale [8,51]. Notwithstanding trenchant criticism in *the Review of the Criminal Courts of England and Wales* (2001) [53], the problem of inadequate publicly funded forensic science access for defence lawyers was never remedied. Instead this historic problem was compounded by the fiscal austerity policies, initiated after 2008 [54]. During the present decade such recessionary trends have affected forensic science and technology funding (all data estimated in real terms) generally:

- Despite an exponential increase in digital forensics, there was a 10 year decline in England and Wales in forensic science expenditure in the order of 28%.
- The above overall change masks an increase in internal police spending of 10% through a decline in external spending (on independent scientific and technology services) of some 65%.
- A 2017 target (Future Forensics OBC (FFOBC)) to reduce forensic science expenditure (based on a slightly different range of criminal justice agencies) in real terms – both external and in-house services (including digital forensics) – by 43% over the next 10 years.

The data behind these trends and plans is generally robust and the overall picture is clear, but detail is lacking and as a result the exact significance of these figures – as generally crime volumes and evidence costs (especially with digital evidence disclosure) have changed significantly because of digital and cyber

developments and many standard forensic science processes have become more efficient – is highly contestable [55].

No wonder that the Forensic Science Regulator has written of ‘existential threats’ and forensic science providers struggling to survive [8]. The police (the main funders of UK forensic science), as shown above, have faced major problems because of fiscal austerity and have sought to manage the consequences of this by prioritising the retention of flexible capabilities by protecting their most experienced cadre of staff, police officers. The problem with the present forensic science funding, management and governance arrangements is that police priorities may necessarily differ from equally legitimate priorities within forensic science and for the criminal justice system as a whole.

Brexit could accelerate rising UK crimes trends. The politics of Brexit – especially talk of ‘retaking control of [UK] borders’ – frequently misrepresents it is consequences for the continued protection of security and well-being in the UK. More restrictive immigration rules will not reduce the scale of cross-border movement. When the UK joined the Common market its resident population exceeded by three times the total number of cross-border movements (excluding with Ireland). Today that situation has been more than reversed. Offending by nationals from other EU member states is disproportionately lower than the size of this group within the UK population [57]. The challenge, therefore, has been and will continue to be that of identifying a small group of criminals within the overwhelmingly law-abiding and tax-paying crowd travelling to the UK from 27 EU states. Speedy and efficient EU information sharing (e.g. forensic bioinformation and, also for safeguarding purposes, criminal records) has been critical for this [58]. It is absolutely clear that the UK government department responsible for border security and policing, the Home Office, has well-founded concerns that Brexit, particularly of the ‘no deal’ variety will weaken border security [59]. A leaked letter originating from senior police circles has revealed anxieties about ‘significant risks to our local communities’ and a forced switch to more expensive and ‘sub-optimal’ policing should access be denied to EU databases such as SISII used to search for terrorist suspects, particularly with a possible ‘no deal’ scenario [60].

The prospect of increased pressures on criminal justice and security capabilities and budgets are paralleled by potentially wider problems. Should Brexit result in a UK firmly outside the Customs Union and Single Market, there will need to be an extension and deepening (in terms of arrival checks) of UK Border controls. (Not all checks will need to be made at the border itself.) For example, increased volumes of documentation about the safety and security of goods entering the UK will need to be verified. Some of this may require more scientifically and technically qualified staff to test compliance with food and product safety regulations [61]. The complexity and timescale of what is required is a consideration that lowers the risk of a ‘no deal Brexit’. In addition to this resulting in the maximum amount of long-term damage to the UK economy, it would also mean major fiscal losses (not just customs tariffs, but also VAT and duties on goods such as tobacco and alcohol). The NAO have estimated that total cost of ‘no deal’ disruption could be some £40 billion or more over a twelve month period [62]. Both factors could intensify further budget pressures elsewhere in the UK public sector, including on police budgets and forensic science expenditure.

One ameliorating factor for such public expenditure pressures is that recent moves to reduce or even cease funding the cost of border control as a public good might continue. As [Table 2](#) illustrates 89% of the cost of the UK border control and immigration system is now funded directly by those crossing the border, or anticipating such travel or seeking to establish their legal status to do so, with substantial cross-subsidy from purchased services such as passports and visas.

Table 2
Funding the UK Border and Immigration Control Systems in 2017–18 [63].

Function	Cost £m	Income £m (as % of Cost)	Balance £m
Border Force (securing the border, managing flows of people and also goods entering the UK)	522.6	22.2 (4.3%)	–500.4
Borders, Immigration & Citizenship Policy and Strategy Group	38.1	5.1 (13.4%)	–33
Immigration Enforcement	430.8	33 (7.6%)	–397.8
UK Visas & Immigration	1,100	1,600 (145.5%)	+500
HM Passport Office	263.7	435.6 (165.2%)	+171.9
Total	2,355.2	2,095.9 (89% of costs)	–259.3 (11% of costs)

The UK Government has earlier stated a target that by 2019–20 border control and the immigration system (excluding asylum functions) should be cost neutral (no net public sector funding) [64]. This and similar policies could not, however, significantly reverse the general financial pressures on criminal justice budgets described in this section.

5. Brexit and the medium-term prospects for UK forensic science and technology

The most likely direct medium-term Brexit risk for UK forensic science is exclusion from and a loss of influence within the EU research community and professional isolation. The increased fragility of the UK forensic science research and case work capabilities have been partly counterbalanced by British forensic science institutional membership ENSFI and participation in EC funded research projects [65]. The fundamental problem for the future will not just be the consequences of Brexit, but will also reflect a damaging historical legacy from the twentieth century whereby English forensic science and medico-legal infrastructure was funded late and inadequately in contrast to other major European countries [66,67] combined with the decade-long steep decline in funding analysed earlier in this paper.

The underlying cause of these problems, however, is not so much inadequate funding as one of organisational fragmentation: narrowly focused public service priorities and responsibilities with little or no space for independent scientific and legal influence over resource allocation and policy making, or even a balanced consideration of the bigger picture. Such organisational fragmentation creates problems when attempting to measure inputs, assess significance, identify departmental responsibilities and find strategic solutions to the problems relating to forensic science and technology. It may also inhibit initiatives to strengthen forensic science and technology institutions by expanding their activities into areas more aligned to the commercial benefits envisaged under the contemporary scientific state paradigm.

The nature of such concerns can be illustrated by three examples of how traditional notions of forensic science are changing:

a) The recent Novichok incidents demonstrated how the Defence Science and Technology Laboratory (Dstl), which is controlled and funded by the UK defence ministry, can acquire a criminal justice dimension. These incidents also illustrate how major costs – the multi-million pound ‘clean-up’ managed by Defra (The Department for Environment, Food and Rural Affairs) [68] – resulting from a forensic science guided response and the source of that guidance can fall on other departmental budgets. Such forensic science from outside the traditional or mainstream criminal justice science community can be of a very high standard and fully integrated with mainstream provision in terms of quality assurance. For example, in 2013 Dstl scientists provided the first authoritative scientific confirmation that chemical warfare agents had been used in Syria. The international scientific credibility of the laboratory’s work

was enhanced by independent accreditation to the international standard ISO 17025:2005 and compliance with the Forensic Science Regulator’s (FSR) Codes of Conduct [69].

- b) The Randox Testing Services result reporting scandal reveals limitations in the conventional approach to the financial analysis of criminal justice costs as in the previous section of this paper. This scandal exposed questions about the reliability of some 10,000 toxicological test reports (mainly driving, but also family (child custody) and civil courts (employment cases). With contingent fee (‘no win no fees litigation’) the greater part of the cost of this failure will be determined in civil litigation (in the English sense of non-criminal proceedings) as the individuals affected by the scandal seek financial compensation for damage and disruption to their lives. It will amount to a considerable sum, but will not be counted in any government analysis of forensic science expenditure [70].
- c) A Government Chief Scientific Adviser’s (Professor Sir Mark Walport) Annual Report (2015) (Walport Report) was subtitled *Forensic Science and Beyond: Authenticity, Provenance and Assurance* to remind scientists that the forensic science they practise or use also has broader societal and economic purposes consistent with the scientific state paradigm. It also exposed further limitations in the institutional knowledge of the true extent of more traditionally conceived forensic science activity. Even if ‘establishing provenance and authenticity and giving assurance in areas such as environmental protection, food and drink, pharmaceuticals and consumer products’ [71], results in criminal prosecutions, these are rarely included in police crime data [72].

The arguments advanced by Walport for new thinking about the scope of forensic science did not extend to questions about the governance or strategic oversight of forensic science. This issue gains additional traction from the extent to which – with the exception of major terrorist incidents, other serious crimes and crises such as the Randox reporting scandal – forensic science is less significant to senior police decision makers (its principal paymasters in the UK) than might be thought. Police forces have estimated that all crime accounts for only 22% of the number of police emergency and priority incidents [73]. A high proportion of crime, in any case, will not require any or extensive forensic work. Also the nature of crime is changing. The ONS (UK national statistical authority) has estimated that by 2015 53% of UK crime had become either cyber-dependent or cyber-enabled [74]. This correlates with the fears at that time shared by 89% of UK internet users who believed that the risk of becoming a victim of cybercrime was increasing [75]. Against this background senior professional and political focus and funding priorities have moved away from the advanced forensic science initiatives at the end of the last century (e.g. DNA in volume crime investigation) to developing the capability to deal with cyber-enabled or enhanced crime that can threaten national security or public service functionality and the problems arising from large volumes of digital evidence. Loveday describes a situation in which UK policing is wrestling with competing challenges [76], yet, as

discussed above, even for new priority areas resources are being squeezed and recent failures, such as disclosure errors in the investigation of serious sexual crimes, have weakened Parliamentary and public confidence in criminal justice [77]. The decline in senior police engagement with many key forensic science disciplines can be inferred from the hitherto tardy performance – other than in respect of digital forensics – compared with Dstl and the main commercial forensic providers, of police laboratory and fingerprint bureaux in achieving independent accreditation and compliance with regulatory standards [78].

Reaching judgements about the nature, significance and scale of problems that affect the ability of forensic scientists and technologists to contribute to a system of justice that is both fair and efficient are beset by problems of definition and poor data, but there appears to be general agreement that the present system is unsustainable. The governmental view or at least that from within policing expressed in the Future Forensics Outline Business Case (OBC) makes it clear that forensic science and technology cannot serve justice and public safety by continuing on its current trajectory [79]. The organisational challenges, as the major changes envisaged in that document are made, will be in ensuring transparency, accountability and sufficiently wide participation in what should be a long-term and strategic process, not simply a cost-cutting exercise.

While there are strong arguments for fundamental change to address problems arising from fragmented departmental responsibility for forensic science that can be made only by government, the forensic science community also needs to be proactive in reacting to new opportunities and challenges. Three possible examples suggested solely to illustrate this general observation about the need for new thinking within both government and the scientific community are given below:

- a) *Possible post-Brexit border controls*: consistent with observations in the Walport Report (quoted above) about the significance of forensic science in areas such as environmental protection, food and drink, pharmaceuticals and consumer products, Brexit is likely to create new demands for government provided or purchased scientific services. The National Audit Office (NAO) have identified, for example, how monitoring control and certification systems may need to be expanded for the import and export of live animals and animal products, as well as many plants [80]. With the UK Government's self-funding approach to border control the introduction or expansion of such services may not compete directly with criminal justice expenditure. It could, especially in the overall climate of decline in criminal justice work, result in an exodus from criminal justice by scientists willing to retrain and companies seeking better opportunities in public health and regulatory science? Would that amount to a threat to the UK forensic science community, or present an opportunity to strengthen UK forensic science by broadening its professional, institutional and economic base?
- b) *Artificial Intelligence (AI)*: the introduction of AI or machine learning into decision making within the criminal justice system has given rise to fundamental epistemological, standardisation and ethical questions of the kind that forensic scientists have been engaged with for decades. For example, questions asked in an inquiry undertaken by the largest English legal professional body, the Law Society, into the likely transformational impact of technology on criminal justice, including algorithmic decision making, included:
 - How can we review/disclose decisions made by the algorithm?
 - What are the post-implementation oversight mechanisms to identify bias in algorithmic decision making?
 - Can the accuracy of the algorithm be validated regularly? [81]
- c) *Digital evidence*: The financial impact on forensic science budgets of the exponential increase in recent years in digital

forensics was noted in Section 4 above. What has already received much greater public and parliamentary attention, however, is shared legacy of disclosure failures. The failure to disclose exculpatory evidence to defence lawyers threatens the fairness of a criminal trial. This is not an abstract principle. A senior prosecution official has admitted to MPs that some people had been wrongly imprisoned because of such errors. Disclosure problems are not new (they were highlighted in five reviews between 2011 and 2017), nor confined to technological or scientific evidence. But widespread ownership and use of digital devices has transformed the volume of potential evidence. It has been estimated that an average of 35,000 pages of data can be downloaded from every single mobile device examined by the police. This data requires skilled analysis to identify robust evidence that is admissible in court. Also sufficient staff time is needed to be to identify potentially exculpatory evidence that should be disclosed to defence lawyers. Problems with disclosure resulted in the high-profile collapse of a number of cases between December 2017 and spring 2018 or in convictions being quashed [82]. The forensic science and technology provider community has a significant role to play in preventing such failures.

6. Conclusions

This article has analysed the factors – in terms of four interlocking issues – that will determine the prospects for UK forensic science and technology in a post-Brexit world: Brexit itself, the evolution of national criminal justice organisational and funding priorities, the increasing interrelationship of science and technology in the forensic domain and the relatively disadvantaged place of forensic science and technology within the contemporary 'scientific state' paradigm. The results are pessimistic for the likely future of UK forensic science and technology.

Uncertain times, however, also offer new strategic opportunities, for example, a potential opportunity, perhaps, to strengthen UK forensic science by broadening its professional, institutional and economic base by reacting positively to any changes in forensic science – broadly conceived – such as new opportunities in public health and regulatory science. Similarly major questions about digital evidence, cyber-enabled or cyber-dependant crime and the potential impact of AI within the justice system will have a resonance for many within the forensic science community. There is likely to be at a minimum great value from forensic scientists sharing insights about the problematic interface of law with science and technology. This could be taken, however, further by realigning professional bodies, governance and public institutions within what might be become a single and more unified forensic domain – for professional, regulatory and policy making purposes (including resource allocation and research coordination) – of science and technology.

A final comment, however, is reserved for an almost remorseless emphasis in national science policies that research should reinforce and underpin the competitiveness of nations. This is very clearly expressed in the Walport Report. The report provided a welcome and stimulating review of traditional conceptions of forensic science and its value, much of which is reflected in this article. Walport's final conclusions, however, were very much focused on the dominant science policy paradigm:

Forensic techniques can be used to demonstrate provenance and authenticity in ways that could increase confidence in markets and, in some cases, create new business models. Knowing, with a high degree of assurance, the provenance of food or clothes, or the authenticity of the antique or the exotic,

will offer opportunities for businesses to add value in new ways

. . . In conclusion, there are important existing and new opportunities for the application of forensic and analytical science and technology. The need for the effective application of these is growing rapidly as citizens increasingly use and provide globalised markets and services, and, in doing so, expand the uses of the internet and world wide web. . . . [83]

This shows how the contemporary paradigm can be applied – to create new professional and institutional opportunities – to aspects of forensic science and technology. Yet it is also necessary to distinguish such commercial strategies from tasks that are ultimately concerned with justice and need to be funded as a public good. It is essential to distinguish between the scope for economic exchange and activities where there is no alternative to public funding that is sufficient to ensure the sustainability of science and technology within criminal justice and related areas of litigation (e.g. in family and public health matters) in a manner consistent with a civilised society.

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