Work pay, contractual changes and employee attrition: evidence from trainee doctors

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Abstract

We investigate how contractual changes in pay terms can affect the retention of public sector workers, by exploiting a nationwide reform that differentially reduced unsocial working hours pay for hospital trainee doctors of the English NHS. Using a longitudinal sample and a novel linkage of administrative datasets, our continuous difference-in-difference strategy leverages the individual pre-reform exposure to unsocial working hours and suggests that the implementation of the new pay terms led to a 6.7% increase in the annual number of trainee doctors leaving the English NHS. As plausible mechanisms, staff survey records indicate that the reform was detrimental to pay satisfaction and increased trainee doctors' intentions to change jobs outside healthcare. These findings align with a theoretical model which incorporates reference-dependent preferences for doctors.

Keywords: JOB CONTRACTS; EMPLOYEE ATTRITION; PAY SATISFACTION; JOB TRAINING; DOCTORS; HOSPITALS; REFERENCE DEPENDENCE.

JEL Codes: I11, J22, J41, J45, J63, J81, C23

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1 Introduction

Workers' compensation in critical public sector services is a contentious issue for governments and policymakers, especially during economic downturns, as it triggers complicated financial trade-offs related to the extension of salary increases to a large workforce. In the absence of either tax hikes or spending cuts, generous pay rises to public sector workers can in fact lead to budget deficits. Nevertheless, a competitive pay package is essential to minimize the attrition of public sector employees towards better-rewarding outside job options, as pay terms are known to affect employee willingness to quit their job (Böckerman and Ilmakunnas, 2009; Dale-Olsen, 2006; Gielen and van Ours, 2006; Breza et al., 2018).

These trade-offs become especially salient when public sector workers provide critical services, such as primary and secondary health care, as high turnover rates of skilled workers can impair the smooth delivery and quality of public services.[1] Following Lazear and Shaw (2007), who suggest using data on single organisations and exploiting exogenous changes in factors that affect employee retention, we provide new evidence on how changes in contractual pay impact skilled workers. Specifically, we evaluate the effects of a 2016 nationwide reform that restructured the pay terms for trainee doctors in English public hospitals and examine its impact on attrition rates, job satisfaction, and intentions to quit.

In August 2016, the UK government imposed a new national contract that increased trainee doctors' basic pay by 10.5% with respect to the pay levels regulated by the former 2002 national contract. However, and quite controversially, the new contract lowered the pay for night and weekend shifts: for example, under the 2016 contract, the theoretical maximum pay supplement granted to trainee doctors for work during weekends was reduced from 100% to 15% of the basic salary, and the pay supplement for night shift from 50% to 37% of the basic salary. On average, the reform resulted in a modest increase in trainee doctors' total pay, whereas it changed its pay composition substantially. This reform was highly unpopular, resulting in a series of trainee doctors strikes (Stoye and Warner, 2023) and, allegedly, the attrition of many trainee doctors from the NHS. Up to now, however, the reasons behind this backlash have been under-investigated, despite their importance in preventing similar failures from a managerial, policy and regulatory perspective.

Our work sheds light on the effects of this reform on NHS trainee doctors' attrition and provides evidence on the mechanisms at play, by exploiting both a theoretical framework and a novel dataset, created through the original linkage of several rich and high-quality administrative data sources. We construct a panel of trainee doctor employment spells across

[1]For example, see Propper and Van Reenen (2010); Kelly et al. (2023); Moscelli et al. (2024) for cases of high hospital staff turnover rates or shortages associated with higher patient mortality.

acute and mental health care NHS hospitals by extracting data from the Electronic Staff Records (ESR), an administrative monthly payroll dataset containing the universe of NHS hospital workers records. These data allow us to examine the impact of the 2016 contract adoption on the attrition of NHS trainee doctors. To explore the underlying mechanisms driving our findings, we link this panel to NHS doctors' survey responses regarding pay satisfaction and intentions to quit. Our main sample includes only trainee doctors who joined the NHS under pre-2016 contractual terms, i.e. those who were exposed to the changes brought by the reform. We track their employment within the NHS through December 2018, distinguishing between those who permanently left the NHS and those who took a temporary break from medical training.

We then exploit trainee doctors' quasi-random heterogeneous exposure to the reform to investigate how their labour supply extensive margins responded to changes in the pay for unsocial working hours. Employing a continuous treatment difference-in-difference (DiD) design (e.g. Propper et al. 2008; Cooper et al. 2011; Gaynor et al. 2013) based on the pre-policy exposure of each trainee doctor to unsocial shifts, we show that the reform had a differential effect on the decision to quit the NHS. Our main findings show that the pay restructuring had a negative effect on retention: we estimate a 6.7% yearly increase in the number of English NHS trainee doctors leaving the English NHS. Our main results are corroborated by the fact that we also find negative effects on trainee doctors' pay satisfaction, and a positive effect on the trainees' intentions to quit the healthcare sector. The results on both pay satisfaction and intentions to leave the hospital organization or the NHS are also robust to falsification tests in which we evaluate the effects of the 2016 contract either by backdating the starting date of the new contract, or by using groups of tenured doctors whose contractual terms did not change.

Our empirical results are well-supported by our theoretical model, which proposes a plausible mechanism for trainee doctors' dissatisfaction following the reform. We study doctors with reference-dependent preferences following the framework of Tversky and Kahneman (1991), and in particular, Kőszegi and Rabin (2006). In this model, a doctor derives both standard consumption utility from earnings and gain-loss utility based on whether earnings exceed or fall below a reference point, which may be based on expected pay or perceived fair pay. We discuss several factors that may contribute to pay dissatisfaction. Specifically, we show theoretically that a trainee doctor with greater pre-policy exposure to unsocial shifts is more likely to be adversely affected by the reform.

Our analysis offers a series of contributions. First of all, we estimate the causal impact of a change in the pay structure on skilled workers' retention, their intention to quit and pay satisfaction. This is usually challenging, due to the scarcity of appropriate sources of

exogenous variation (Lazear and Oyer, 2019; Glaser and Rahman, 2023), and the existing evidence remains limited and inconclusive. In private, non-healthcare sector settings, there is evidence that adverse working conditions increase the intention and probability to quit (Böckerman and Ilmakunnas, 2009); that increasing wages can be effectively used to reduce workforce turnover (Dale-Olsen, 2006; Gielen and van Ours, 2006); and that pay terms affect employee willingness to enter employment, or quit, at a given remuneration level (Breza et al., 2018). Consistently, we find evidence that changing the structure of the total remuneration package, as in the case of the new 2016 contract for NHS trainee doctors, may influence a worker's decision to quit their job. Our work also relates to the literature examining the role of work shifts, schedules and arrangements in shaping employee preferences and labour supply decisions (Hamermesh, 1999; Kostiuk, 1990; Mas and Pallais, 2017; Senney and Dunn, 2019). Indeed, both our conceptual framework and empirical analysis show that the decrease in the extra pay for unsocial shifts may have caused an increase in trainee doctors' attrition.

As most of the evidence on the effect of pay on employee retention focuses on private sector employers, less is known for large public sector organizations, like the English NHS, where pay conditions and career progression are heavily regulated, and incentives are different from those in profit-maximizing settings. The existing evidence about the impact of working conditions on the retention and labour supply in the public sector is mixed (Duflo et al., 2012; Fryer, 2013; Glaser and Rahman, 2023); our work provides novel findings to this research stream, by showcasing how failing to account for the reference-based utilities of workers may increase their quit rates. Field and laboratory studies provide strong evidence that workers exhibit reference-dependent preferences. For example, Mas (2006) investigates how expectations of pay raises influence police officers' performance, showing that raises falling below a reference point lead to decreased performance.

We also contribute to the understanding of a critical policy issue of the last two decades, that is, investigating the factors determining the shortage of healthcare professionals and hospital care workers in developed OECD countries, such as the UK (White, 2012; Alderson and Alladi, 2014; Iacobucci, 2018), the United States, Italy, France, Canada, and Switzerland (Scheffler and Arnold, 2019; Gong et al., 2019; Zhang et al., 2020). The English NHS has been experiencing workforce shortages since the start of the 2010s, and it substantially relies on attracting healthcare employees from other countries; a process that has become harder after Brexit.[2] Understanding how working and remuneration conditions affect the

[2]As of March 2021, official statistics show that at least 30% of the around 124,000 doctors in the English NHS are non-UK nationals (`https://commonslibrary.parliament.uk/research-briefings/cbp-7783/`). Moreover, 4.8% of planned full-time equivalent (FTE) medical workforce levels were estimated to be vacant (`https://digital.nhs.uk/data-and-information/publications/statistical/nhs-vacancies-survey/april-2015---march-2021`).

physician labour supply decisions remains contentious and widely debated (Lee et al., 2019). In the medical literature, the existing evidence is often descriptive and prone to non-random response bias (Kmietowicz, 2015; Cleland et al., 2016; Spooner et al., 2017; Scanlan et al., 2018). The health economics literature on physician labour supply suggests that the doctors' labour supply curve is quite inelastic, partly due to the highly specialized nature of their job, which limits their outside options; for example, both Rizzo and Blumenthal (1994) and Andreassen et al. (2013) find small short-run physician wage elasticities.

Finally, the focus on trainee doctors' attrition is also an important feature of our study. Financial incentives are known to be relevant for the location decisions of early-career physicians (Agarwal, 2017; Chatterji et al., 2018), but there is a lack of robust causal evidence on the factors affecting physicians' decisions to quit during their on-the-job training period – which is exactly the objective of our research. Trainee hospital doctors are a subgroup of skilled medical staff who are on the steep part of the age-earnings profile, given their training status: whilst their remuneration may be still relatively low, their opportunity cost in terms of missed human capital accumulation and viable outside options (e.g. leaving to practice in another organization or country) are relatively high.[3] It follows that trainee doctors' retention rates may be responsive to improvements and deteriorations in their working conditions: in fact, we show that altering the pay structure affects the extensive margin of the trainee doctors' labour supply.

The remainder of this paper is structured as follows. Section 2 illustrates the key features of the English National Health Service (NHS), the training pathway to become a qualified doctor in the UK, and the contractual changes introduced in 2016 by the new trainee doctors' contract. Section 3 illustrates our conceptual framework and the hypotheses being tested. Section 4 presents the data and outlines our empirical strategy. Section 5 reports the baseline results and tests their robustness. Section 5.5 investigates the mechanisms behind the main findings of the paper. Section 6 concludes.

2 Background

2.1 The English NHS and its physician workforce

In England, most of the healthcare provision is state-provided by the National Health Service (NHS), which is funded by taxation and free at the point of use. While primary care physicians, called General Practitioners (or GPs), are private and subcontracted by the NHS,

[3]For example, OECD statistics show that the total number of the UK-trained doctors in Australia rose from 3,949 in 2013 to 6,621 in 2021; see `https://stats.oecd.org/Index.aspx?DataSetCode=HEALTH_WFMI`.

secondary care doctors are directly employed by the NHS and work in healthcare organizations called Trusts, which manage one or more hospital sites. According to publicly available NHS Workforce Statistics (June 2021), the total NHS Hospital and Community Health Service (HCHS) medical workforce headcount is nearly 120 thousands, with about 63,300 fully qualified doctors, i.e. senior doctors, and 60,400 trainee doctors.[4] Between 2009 and 2019, the overall number of doctors employed by NHS organizations has grown by around 29.5%. The remuneration and working conditions of the NHS clinical staff are centrally regulated. The Review Body on Doctors' and Dentists' Remuneration (DDRB) provides advice to the UK government on the remuneration of doctors (and dentists) employed by, or providing their services to, the NHS. Any governmental decision on pay and work contract terms is then set at the national level through NHS Employers, which represents the workforce leaders from all NHS organizations.

Within the English National Health Service (NHS), the mounting loss of trainee doctors (also known as *junior doctors* in the NHS and *resident doctors* in the US) - medical graduates undergoing postgraduate in-hospital training - is of particular relevance, as they represent the future of the NHS medical workforce. About 10-15% of home-trained doctors in the UK end up practising abroad, a share which has increased since the implementation of the 2016 national contract and which is substantially higher than the share of home-trained doctors by neighbouring European countries with similar healthcare systems (see Burn-Murdoch 2023, as well as our elaboration of OECD data reported in Appendix Figure A.1).[5] Moreover, a growing number of trainee doctors decides to interrupt at least temporarily their UK-based medical training, with the share of NHS trainee doctors who immediately took up a specialty post after their general training programme decreasing from 71.3% in 2011 to 37.7% in 2018 (Rimmer, 2019).

The growing attrition of trainee doctors is frequently linked to unfavourable working conditions in the NHS, such as a stretched work-life balance, inadequate pay for the amount of work provided, unappealing training and job opportunities (Smith et al., 2018; Lambert et al., 2018; Moss et al., 2004; Rizan et al., 2019); and doctors' attrition is of further concern, as it may have adverse effects on hospital quality and patient outcomes by lowering staffing levels below safety thresholds (Lin, 2014; Akosa Antwi and Bowblis, 2018; Stoye and Warner, 2023).

[4] `https://digital.nhs.uk/data-and-information/publications/statistical/nhs-workforce-statistics/june-2021`.

[5] Over the last 15 years a growing number of UK-trained doctors has relocated to work to Australia, New Zealand and the USA (Appendix Figure A.2), as expected given the same spoken language and the fast-track route for healthcare professionals to move to some of these countries, e.g. Australia.

2.2 Organization of medical training in the English NHS

After graduating from medical school, NHS trainee doctors undertake in-hospital training to become fully qualified doctors. To enrol in the training program, medical graduates have to participate in a national application process that operates on a preference-based system. During this process, they are required to rank all 18 Foundation Schools in the UK, 15 of which are located in England, according to their personal preferences.[6] While making their selections, candidates must carefully weigh factors such as their desired training location and the level of competition they may encounter from other applicants. Provided that there are sufficient training posts available, medical graduates secure their placement in primary preference. Otherwise, they get allocated to their next highest-ranked Foundation School with still available open posts.[7]

Since the introduction of the 2005 Modernising Medical Careers (MMC) programme, training consists of two stages. The initial stage includes a two-year foundation programme, during which trainees develop fundamental skills and essential knowledge for practicing medicine. This foundation training is succeeded by a specialty training, which spans from five to eight years, depending on the chosen medical specialty following the successful completion of the foundation programme.[8] An important exception is the general practitioner track, which requires only three years of specialty training. Overall, it can take up to ten years for a trainee doctor to successfully qualify as a senior doctor in English NHS hospitals.

During Foundation Years 1 and 2 (FY1 and FY2, respectively), trainee doctors undergo rotations across various hospitals and medical specialties. This feature of the training enables them to gain essential experience by being exposed to diverse work environments and performing a range of medical tasks. Rotations take place every three to six months; however, the most important rotation date is the first Wednesday of August, when newly graduated medical students begin their own in-hospital training. Trainee doctors typically rotate across hospital organizations within the same Foundation School where they were admitted for their foundation training. The assignment of rotations is determined by the local Health Education England (HEE) offices.[9] Thus, trainee doctors have no influence on their placements across hospitals and medical specialties, once they are admitted to the regional program they

[6] Foundation Schools, also known as NHS deaneries before 2013 or Local Education and Training Board from 2013 onwards, are the organizational structures responsible for postgraduate medical and dental training at the local regional level, and they comprise several Trusts.

[7] In 2015, 68% of medical graduates were allocated to their first Foundation School choice (Cartwright, 2015).

[8] For some specialty areas (e.g. Anaesthetics, Emergency Medicine, Psychiatry), the specialty training is split into two further stages: core training and higher specialty training. The core training lasts up to three years, after which trainee doctors need to reapply for higher specialty training. The remaining specialty areas instead involve a run-through specialty training and only one application process.

[9] See Figure A.3 for a map of HEE regions and subregions.

originally applied for.[10]

Even specialty trainees (often referred to as Specialty Registrars; SR hereafter) rotate across hospitals, although at a lower frequency than foundation doctors. At the successful completion of their specialty training, trainee doctors are awarded the Certificate of Completion of Training (CCT).[11]

2.3 The 2016 Trainee Doctor Contract (2016 TDC)

The working conditions of trainee doctors in English hospitals are governed by national agreements, typically negotiated and amended by three key parties: the Department of Health and Social Care (DHSC), NHS Employers, and the British Medical Association (BMA), which is the largest doctors' union in the UK. In 2016, a new contract brought substantial changes compared to the existing contractual pay terms of 2002. The agreement on the new contract was finalized in May, following a compromise reached after an extensive series of negotiations that led to months of industrial actions by trainee doctors.[12] The magnitude of these protests is illustrated in Appendix Figure A.4, plotting the timeline of trainee doctors' absences from the workplace. However, the new contract was only implemented in August 2016.

One of the stated objectives of the reform was to ensure a consistent provision of healthcare services in terms of quantity and quality throughout the entire week.[13] At the same time, to ensure the financial sustainability of hospital services, the new contract substantially reduced the cost for NHS organizations to roster trainee doctors during nights and weekends, as shown in Table 1. According to the new contractual terms, NHS trainee doctors received a 10.5% basic salary pay rise, but also substantial cuts to their unsocial working hours pay. Under the 2016 contract, the trainee doctors' monthly pay for working on weekends was capped at a 15% pay rate premium over their basic pay. In contrast, the supplement pay under the 2002 contract was capped at 100% of a trainee doctor's basic salary, and effectively quantified between 20% and 50% of their hourly basic salary, as shown in Table 2 and further

[10] See for instance: `https://www.bma.org.uk/news-and-opinion/junior-doctors-backed-in-call-for-humane-rotations`.

[11] The possession of a CCT makes doctors eligible for inclusion in the Specialty Register, enabling them to apply for senior doctor job positions in English NHS hospitals.

[12] On January 12, 2016, trainee doctors initiated their first strike within the NHS in 40 years. Industrial action persisted in the subsequent months, with trainee doctors abstaining from work on February 10th, March 9th-10th, and April 26th-27th. During this last instance, they not only withdrew from routine care, as in previous strikes, but also from emergency services.

[13] A main concern of the government was to address the higher mortality risk faced by patients admitted to NHS hospitals during weekends (Aylin et al., 2010; Freemantle et al., 2012, 2015; Han et al., 2018). However, subsequent studies have shown that the implementation of the new contract might not have reduced weekend hospital mortality (Meacock and Sutton, 2018; Underwood et al., 2019).

discussed in subsection 4.2.

The 2016 contract also reduced the compensation for other types of unsocial work. Indeed, it decreased the pay premium for night shifts, from 1.5 to 1.37 times the basic hourly pay, as well as that for additional hours worked beyond the maximum of 40 hours per week, from 1.2 to 1.0 times the basic hourly pay.[14]

The aforementioned pay changes introduced by the new contract are shown in Figure 1, which plots the monthly average total earnings (*Panel A*), basic pay (*Panel B*) and unsocial hours supplement earnings (*Panel C*) over time and by trainee seniority. On average, while the total monthly earnings slightly increased as a result of the new terms (*Panel A*), and the overall number of hours worked remained stable (see Appendix Figure A.5), the new contract substantially restructured the composition of trainee doctors' pay. This change involved a significant decrease in the proportion of pay attributed to the unsocial hours pay supplement (*Panel C*). For this exact reason, the BMA union judged the 10.5% increase in basic pay as potentially "misleading, due to the changes to pay for unsocial hours" (The Guardian 2016a).

3 Conceptual Framework

In this section we propose a theoretical framework to formalize the trainee doctors' dissatisfaction with the pay changes introduced by the 2016 contractual reform. Our theoretical framework proposes a plausible mechanism for doctors' dissatisfaction following the reform.

We assume that a doctor has reference-dependent preferences (Kahneman and Tversky, 1979 and Tversky and Kahneman, 1991) such that the doctor evaluates their earnings with respect to a reference point. Existing field and laboratory studies provide robust evidence that workers exhibit reference-dependent preferences.[15] In our proposed framework, the doctor derives intrinsic utility from earnings and experiences gain-loss utility depending on whether earnings exceed or fall below the reference point. To illustrate the role of reference points, consider two identical doctors who receive the same salary increase, say, 5%. Suppose Doctor 1 expected an increase of 10%, while Doctor 2 did not expect any increase. Although

[14] The terms of the 2016 TDC alongside its amendments are available at: `https://www.bma.org.uk/pay-and-contracts/contracts/junior-doctor-contract/junior-doctor-contract-in-england`.

[15] For instance, Mas (2006) examines both theoretically and empirically how police officers' performance may depend on the expectations of pay raises, finding that pay raises below a reference point decrease performance. Bracha et al. (2015) examine the impact of pay relative to other people on labour supply in a controlled laboratory setting; their findings indicate that earnings affect labour supply decisions significantly, demonstrating the presence of reference-dependent preferences. Fehr and Goette (2007) use data from both field and laboratory to show that bike messengers exhibit loss aversion relative to reference points in their wage expectations.

the increase in earnings is the same for both doctors, Doctor 1 is less satisfied than Doctor 2 since the increase did not meet their expectations.

As we study the effect of a contractual reform, we assume that the doctors' reference point for their post-reform earnings is determined by their expectations from the reform or what they think is fair.[16] We follow the theoretical framework developed by Kőszegi and Rabin (2006) to model a trainee doctor before and after the reform.[17] A doctor's utility depends both on their consumption bundle and reference bundle. The doctor has an intrinsic consumption utility that corresponds to the standard utility. They also derive gain-loss utility due to a departure from the reference point. Both consumption utility and gain–loss utility are separable across dimensions, i.e., across basic pay and unsocial hours pay, and overall utility is the sum of intrinsic utilities and gain-loss utilities in all dimensions.[18]

Consider a doctor who has the total monthly earning $s + e$ where $s \geq 0$ is the basic salary and $e \geq 0$ is the extra pay for unsocial hours. The doctor evaluates their outcomes with respect to a reference point, which serves as the zero point of the value scale, and they derive an intrinsic consumption utility and a gain-loss utility from their earnings. Let $\tilde{s}$ be the reference point for the monthly basic salary and $\tilde{e}$ be the reference point for the monthly extra pay for the doctor. Following the framework in Kőszegi and Rabin (2006), we define the doctor's utility function as

$$U(s, e|\tilde{s}, \tilde{e}) = u(s) + u(e) + v(s|\tilde{s}) + v(e|\tilde{e}), \tag{1}$$

[16] There is not always a straightforward answer to what determines reference points. Studies that link earnings and effort provision commonly assume that reference points are determined by status quo, expectations or anticipated earnings (Abeler et al., 2011), what is considered fair or past earnings (Cohn et al., 2013, Dube et al., 2019), and peer comparisons (Pfeffer and Langton, 1993, Falk and Knell, 2004, Bracha et al., 2015, Ockenfels et al., 2015). Negotiations between the BMA and the government lasted several months, with multiple revisions to the offer. The reform also led to strike actions, making it a prominent topic of discussion among public for an extended amount of time, creating a natural environment for doctors to form expectations or evaluate what is fair.

[17] The framework of Kőszegi and Rabin (2006) has been widely adopted and tested in both experimental and field settings. Abeler et al. (2011) directly test the theory in a real-effort experiment, finding strong evidence that workers' effort choices are influenced by their expectations. Crawford and Meng (2011) show that expectation based reference-dependence is an important determinant of New York City cab drivers' labour supply using Kőszegi and Rabin (2006) model.

[18] The separability assumption implies that people assess gain–loss utility in each dimension separately. This is a general and useful assumption since it allows an individual to exhibit different levels of loss aversion in different dimensions. For instance, a doctor may have different levels of loss aversion for basic and unsocial hours pay, or may care gain-loss utility in one more than the other. In their model, Kőszegi and Rabin (2006) derive reference points endogenously as an equilibrium outcome but we abstract from such considerations and derive our results for any given reference points.

where u is the intrinsic consumption utility and v is the gain-loss utility defined as

$$v(x) = \begin{cases} \eta\left[u(x) - u(\tilde{x})\right] & \text{if } u(x) - u(\tilde{x}) \geq 0, \\ \lambda\eta\left[u(x) - u(\tilde{x})\right] & \text{if } u(x) - u(\tilde{x}) < 0 \end{cases} \tag{2}$$

for each $x \in \{s, e\}$. In this formulation, the parameter $\eta \geq 0$ captures how salient gain-loss utility is relative to consumption utility and $\lambda \geq 1$ captures the degree of loss aversion. In its most general form, the parameters η and λ in the value function are consumption specific; so, they may take different values for basic pay and extra pay, λ_x, η_x for $x \in \{s, e\}$. To analyze the general implications of a reference-dependent model, we first abstract from this and assume homogeneous parameters across dimensions. We will then assume full generality and discuss a specific example which makes a straightforward link between our theory and empirical analysis. We also assume that u is strictly increasing and differentiable.

We study the effect of a contract change on the doctor's overall utility. We consider the doctor in two time periods, before and after the reform, where $t = 0$ refers to before the reform and $t = 1$ refers to after. Let s_t, e_t, $\tilde{s}_t$, $\tilde{e}_t$ be the components of the earnings and reference points respectively at a given time $t = 0, 1$. We write U_0 for the utility of the doctor pre-reform and U_1 for the utility after. We make the following assumptions that align with the context of our application.

A1: $s_1 + e_1 > s_0 + e_0$ and $u(s_1) + u(e_1) > u(s_0) + u(e_0)$.

A2: $s_1 > s_0$ and $e_1 < e_0$.

A3: $\tilde{s}_0 = s_0$ and $\tilde{e}_0 = e_0$.

The first part of assumption A1, as well as assumption A2, follows directly from the data, as illustrated in Figure 1. Since basic pay constitutes a larger portion of total income, the second part of A1 – where we assume that overall consumption utility post-reform exceeds that of the pre-reform – appears to be a reasonable assumption. Furthermore, we assume that each pre-reform reference point corresponds to the relative earnings of the same period. This implies that the pre-reform gain-loss utility is zero. This is mainly for convenience, but it is also natural to assume that reference points converge to the status quo when a contract has been in place for a very long time like the 2002 national contract.[19]

By A3, we have $U_0 = u(s_0) + u(e_0)$. The exact form of U_1 depends on the relationship between consumption level and its corresponding reference point in each dimension. In general, U_1 is the sum of intrinsic consumption utilities derived from new earnings and the gain-loss utilities based on expectations under the new contract; i.e., $U_1 = u(s_1) + u(e_1) + v(s_1|\tilde{s}_1) + v(e_1|\tilde{e}_1)$. Since our objective is to identify the conditions under which the doctor

[19] Our results easily extend to the case where pre-reform reference points are defined by what is expected/considered fair ($\tilde{s}_0 \geq s_0$ and $\tilde{e}_0 \geq e_0$) and we can obtain analogous findings.

is worse off after the reform, our main parameter of interest is $\Delta U := U_1 - U_0$ whose actual form changes with U_1. Let us write U_1 generally for any level of $\tilde{s}_1$ and $\tilde{e}_1$:

$$U_1 = u(s_1) + u(e_1) + \eta \sum_{x \geq \tilde{x}_1} [u(x_1) - u(\tilde{x}_1)] + \lambda\eta \sum_{x < \tilde{x}_1} [u(x_1) - u(\tilde{x}_1)]$$

where $x \in \{s, e\}$. The doctor is worse-off after the reform if and only if $U_1 < U_0$; hence, if and only if

$$u(s_1) + u(e_1) + \eta \sum_{x \geq \tilde{x}_1} [u(x_1) - u(\tilde{x}_1)] + \lambda\eta \sum_{x < \tilde{x}_1} [u(x_1) - u(\tilde{x}_1)] < u(s_0) + u(e_0),$$

which can be equivalently written as

$$\frac{u(s_1) + u(e_1) - u(s_0) - u(e_0)}{\eta} < -\sum_{x \geq \tilde{x}_1} [u(x_1) - u(\tilde{x}_1)] - \lambda \sum_{x < \tilde{x}_1} [u(x_1) - u(\tilde{x}_1)]. \quad (3)$$

The numerator on the left-hand side of (3) is the gain in intrinsic consumption utility under the new contract. Let us denote this gain as Δu (which is always greater than 0 by A1). The right-hand side is the (negative of the) sum of the gain utility resulting from the contract exceeding expectations in some dimension and the loss utility resulting from the contract failing to meet expectations in another dimension.

We are now ready to state our main result.

Proposition 1 *ΔU decreases (making it more likely that the doctor is worse-off) if*

1. *Δu, the gain in intrinsic consumption utility from the new contract, is low.*
2. *the loss aversion is strong, that is, if λ is high.*
3. *the salience of gain-loss utility is strong, that is, if η is high.*
4. *the after-reform reference points, $\tilde{s}_1$ and $\tilde{e}_1$, are high.*

As Proposition 1 shows, there are several scenarios in which Equation (3) holds when preferences are defined by Equation (1). In general, when Δu cannot offset the utility loss from reference dependence, Equation (3) holds and $\Delta U < 0$.

We now examine a benchmark case where post-reform earnings exceed expectations.

Proposition 2 *If $s_1 \geq \tilde{s}_1$ and $e_1 \geq \tilde{e}_1$, then $\Delta U > 0$.*

When the doctor perceives both their post-reform earnings components as exceeding expectations, there is no loss utility, and under A1, ΔU is always positive. Given that the standard

consumption utility from the new earnings exceeds the consumption utility from the old, a doctor is always better-off as long as the monetary value of the new contract does not fall below expectations.

In our empirical analysis, we argue that the decision to quit depends not only on the absolute monetary value of the unsocial pay supplement, or its value relative to basic pay, but also on how trainee doctors with higher pre-policy exposure valued that specific pay attribute. Below, we discuss the differential effect of a decrease in unsocial pay among those who had higher exposure. Let UNS denote the pre-policy exposure to unsocial hours, defined as e_0/s_0. We first discuss the effect of UNS on the change in consumption utility and then on the change in gain-loss utility.

Exposure to unsocial hours (UNS) and consumption utility

Let us decompose Δu as $\Delta u(s) + \Delta u(e)$, where $\Delta u(s) = u(s_1) - u(s_0)$ and $\Delta u(e) = u(e_1) - u(e_0)$. Both $\Delta u(e)$ and $\Delta u(s)$ components vary between doctors with the same level of pre-reform consumption utility but different levels of exposure to unsocial working hours. Let us also assume for simplicity that utility is linear in money but our discussion below and the result hold for a much larger class of utility functions. (See the Appendix for a full characterisation and proofs). The general decrease in e disproportionately affects those whose earnings depend more on unsocial pay. Consequently, the utility loss $\Delta u(e)$ from a reduction in e is greater for a more exposed doctor than for a less exposed doctor. Similarly, the utility gain $\Delta u(s)$ from an increase in s is smaller for a more exposed doctor than for a less exposed doctor. Thus, for these trainees, the reduction in e leads to a greater decline in Δu while the increase in s results in a comparatively smaller relative gain in Δu than for less exposed doctors, given that their pre-reform consumption utilities are the same. By part (1) of Proposition 1, which states that a decrease in Δu raises the probability of a doctor being worse-off, we conclude that doctors with high UNS are more likely to be disadvantaged under the new contract than those with low UNS.

Remark 1 *Consider two doctors with the same level of pre-reform consumption utility but different levels of exposure UNS. The doctor with high UNS is more likely to be disadvantaged under the new contract than those with low UNS, all else equal.*

Exposure to unsocial hours (UNS) and gain-loss utility

In this part, we allow basic pay and unsocial hours pay to have asymmetric effects on the total gain-loss utility.[20] Suppose the doctor with high pre-policy exposure to unsocial work

[20]Table 4 in the empirical analysis clearly shows that these two components of overall earnings have asymmetric contributions to pay satisfaction.

hours has a stronger loss aversion and/or stronger loss utility salience in this dimension. Specifically, we assume that λ_e and η_e are both functions of pre-policy unsocial hours exposure UNS and they are increasing in UNS.[21] To isolate the effect of a decrease in unsocial pay, we further assume $s_1 = \tilde{s}_1$, $e_1 < \tilde{e}_1$, and $e_1 < e_0$. Then, $\Delta U < 0$ if and only if

$$u(s_1) + u(e_1) - u(s_0) - u(e_0) < \lambda_e(UNS)\eta_e(UNS)[u(\tilde{e}_1) - u(e_1)]. \tag{4}$$

The left-hand side of (4) is the sum of the gain in consumption utility which we discuss above. The right-hand side is the loss utility from the unsocial hours pay being below expectations. The loss utility is high when exposure is high and when $\tilde{e}_1$ is high. We conclude with the following remark.

Remark 2 *Let $s_1 = \tilde{s}_1$ and $e_1 < \tilde{e}_1$. ΔU decreases (making it more likely that the doctor is worse-off) if*

1. *$\lambda_e(UNS)\eta_e(UNS)$ is high, which is the case when the pre-policy exposure to unsocial hours, UNS, is high.*

2. *$\tilde{e}_1$ is high.*[22]

Our model explains the differential impact of a decrease in unsocial pay on those with greater exposure to unsocial hours and provides insights into the possible mechanisms through which UNS influences the job satisfaction of trainee doctors.

3.1 Hypotheses tested

Based on the extant research and our conceptual framework, we test the following set of hypotheses.

Hypothesis 1 (HP1). *Before the 2016 reform, unsocial hours pay is positively associated with trainee doctors' pay satisfaction.*

Hypothesis 2 (HP2). *The higher the individual exposure to unsocial work during the pre-reform period, the higher the increase in trainee doctors'* attrition from the NHS *due to the 2016 contractual reform.*

[21] The estimates of these parameters from the field are consistent with this idea that people can be loss averse in different degrees in each dimension. For instance, Crawford and Meng (2011) find that the estimated λ for hours worked on a day is always larger than that for income on a day in the study of cab drivers' labour supply. Kőszegi and Rabin (2003) argue that consumption goods are generally a mixture of hedonic attributes and gain-loss utility should allow a different dimension for each.

[22] Another mechanism through which UNS may impact the job satisfaction is through affecting the reference point. Those whose earnings are more dependent on the unsocial hours pay may have higher expectations or a higher level in mind which they think is fair.

Hypothesis 3 (HP3). *The higher the exposure to unsocial work during the pre-reform period, the higher the decrease in trainee doctors'* pay satisfaction *due to the 2016 contractual reform.*

Our empirical analysis of the effects of the 2016 reform is based on the comparison between trainee doctors who experienced different unsocial work patterns during their training in the pre-reform period. Due to rotations across different hospital organizations and medical specialties, medical trainees are exposed to different unsocial working hours patterns. Trainees more exposed to unsocial work environments enjoyed a higher supplement pay as a compensation for their larger amount of unsocial work; consistently with HP1, it is reasonable to believe that the unsocial work extra pay component could have had a higher values for these trainees than for their less exposed peers (Maestas et al., 2023).

At the same time, unsocial work hours represent an unappealing but mandatory job attribute, which trainee doctors must accept during their training period as NHS workers. A cut in the unsocial hours pay relative to the total salary package is likely to have generated a disincentive to remain employed in English NHS hospitals, despite the compensating increase in basic pay, for the trainees more exposed to unsocial work. Therefore, we hypothesize that the 2016 TDC could have caused unintended detrimental effects for the trainees more exposed to unsocial work, by respectively reducing trainees' retention within the NHS (HP2) and pay satisfaction (HP3) for those who did not quit the NHS training. These detrimental effects would arise also because the unsocial working hours patterns are relatively persistent over the years during a NHS trainee doctor career, even after the foundation training (as shown in Appendix Table A.7, subsection 5.4).

With respect to our specific institutional setting, it is also worth noting that the impact of the 10.5% nominal increase in basic pay brought by the 2016 reform is a priori ambiguous on trainees' retention and pay satisfaction. A pay increase in real terms is likely to increase both workers' retention and pay satisfaction. However, as summarised by Appendix Figure A.6, the 10.5% basic pay rise was barely sufficient to keep the real terms take-home salary of trainee doctors stable, and approximately at a 22% lower level than their 2008/09 pay (BMA 2022). Hence, the 10.5% basic pay rise was likely regarded in trainee doctors' pay expectations more as a delayed compensation for lost purchasing power than as a genuine salary increase. Furthermore, the basic pay increase was deemed unsatisfactory by trainee doctors, as it fell short of the initially promised 13.5% salary increase, which had been retracted by the UK government (The Guardian 2016b).

Based on the above facts and considerations, we expect the likely impact of the 2016 basic pay increase on trainee doctors' retention and pay satisfaction to be positive but rather small.

Moreover, as this basic pay increase affected all NHS trainee doctors without any exclusion, there is no variation that we can exploit in the data to evaluate empirically its actual impacts.

4 Data and Methods

4.1 Electronic Staff Records (ESR) and other data sources

Our analysis is primarily based on the Electronic Staff Records (ESR), an administrative dataset collected by DHSC and containing monthly individual-level payroll information on all healthcare workers of the English NHS. We focus on an ESR extract including trainee doctors (TDs hereafter) who joined the NHS under the 2002 agreement, and thus who were exposed to the change in their contractual terms brought by the introduction of the 2016 TDC.

We restrict the attention to trainee doctors who entered the NHS medical training starting from August 2009 and as Foundation Year 1 (FY1). These trainees went through the standard pathway of the NHS medical training and - for this reason - were subject to a series of comparable hospital rotations, which provide the source of variation in unsocial work exploited by the analysis. We discard from the analysis all trainee doctors who had ever been classified under a non-doctor title (391) or who always lacked a General Medical Council (GMC) number (3,252).[23] We also exclude the specialty training spells (i.e. records after FY2) of trainee doctors entering a specialty training in General Practice (GP track). Indeed, most GP trainees disappear from the NHS payroll right after the completion of their training programme, when they either open or are employed by a GP practice, thus preventing us from assessing precisely if and when they interrupt their medical training.

Our estimation sample goes from January 2010 to December 2018, a long enough post-contract period to assess whether trainee doctors permanently left the NHS or took only a temporary training break (see Section 4 for more details). We split specialty trainees in two groups, based on the first three years and the subsequent years of specialty training. To distinguish between different stages of the specialty training over time, we compute the cumulative full-time equivalent spent actively into specialty training. The final sample consists of 40,954 trainee doctors followed over 8 years, i.e. 1,761,537 observations in total.

Appendix Figure A.7 illustrates the other data sources that we use in this work, and how

[23] This information is retrieved by linking the ESR records with an extract of the 2013-2019 HERMES dataset. We also drop from the sample 8,681 dental trainees, who undergo a slightly different training than trainee doctors, which for instance involves only one Foundation year. Finally, we discard both trainee doctors with just one-month training spells and those whose training grade cannot be harmonized with the standard medical training pathway.

they are linked to the trainee doctors' employment panel dataset. The HERMES dataset, collected by Health Education England (HEE) and reporting an annual snapshot of the English NHS hospital workforce, is used to refine the sample of trainee doctors and to attribute a Foundation School record to each trainee doctor. Trainee doctors' responses about their satisfaction with pay and intentions to quit are extracted from the worker-level NHS Staff Survey (NSS), the largest survey of healthcare workers' satisfaction in the world which is carried out each year, from September to November, across all NHS hospital organisations. We use these data to explore the mechanisms of our main findings and in particular to investigate the effects of the 2016 contract on trainee doctors' pay satisfaction and intentions to change jobs outside healthcare.

4.2 Measuring the exposure to unsocial work

The ESR does not record the amount of unsocial working hours. In order to estimate the effect of the 2016 TDC on trainee doctors' retention, we therefore construct a measure of treatment exposure based on the pre-contract pay granted to foundation doctors as a compensation for the amount of unsocial work hours done. Specifically, until August 2016, trainee doctors were paid a monthly pay supplement on top of their basic salary that depended on (i) the average number of weekly hours worked, and (ii) the number of hours worked during unsocial shifts.[24]

Table 2 summarizes the 7 bands that were applicable to a trainee doctor appointment under the 2002 contractual terms, together with the associated pay supplement as percentage of the basic salary. The last column confirms that the supplement pay for unsocial work granted by the 2002 contract was significantly higher than that associated with the 2016 contract (see Table 1). For instance, working 48-56 hours per week implied a pay supplement of either 50% or 80% of the basic salary, depending on whether trainee doctors worked more or less than 1 weekend in 3. However, in practice trainee doctors cannot work more than 48 hours a week, unless they opt out from the regulation embedded by the European Working Time Directive. For this reason, our treatment exposure variable is exclusively based on unsocial supplement earnings, which in our period of study mostly varied by the amount of work done during unsocial hours, rather than by the intensity of the working schedule.[25]

We construct a measure of individual exposure to unsocial work in three steps. First, we compute the unsocial earnings share as the ratio between trainee doctors' unsocial supple-

[24]The terms of the 2002 TDC, along with its amendments, are available at: `https://www.nhsemployers.org/articles/old-terms-and-conditions-service-medical-and-dental-staff`.

[25]Still, subsection 5.4 explores the sensitivity of our results to the role played by a potential confounding factor like the intensity of the working schedule.

ment pay and their basic salary, in each hospital organization h and calendar month t, i.e. $\frac{UnsocialPay_{i,h,t}}{BasicSalary_{i,h,t}}$. Second, for each hospital organization h and month t, we take the median of these ratios among foundation doctors only, $\overline{UNS}^{FY}_{h,t} = \text{med}(\frac{UnsocialPay^{FY}_{i,h,t}}{BasicSalary^{FY}_{i,h,t}})$. Higher values of this ratio indicate a more unsocial working environment for the hospital trainee doctors in a given month. Third, in order to introduce individual-level variation, we attribute $\overline{UNS}^{FY}_{h,t}$ to each trainee doctor employed at hospital organization h in month t, and then take the average across all the pre-contract monthly observations for each trainee doctor i, which gives:

$$UNS_i = \frac{\sum_{h,t}[\overline{UNS}^{FY}_{h,t} * I_i(h,t)]}{\sum_{h,t} I_i(h,t)}, \tag{5}$$

where $I_i(h,t)$ is an indicator for observing trainee doctor i at time t in Trust h. Thus, UNS_i is a measure of exposure to unsocial work in hospital organizations before the introduction of the 2016 TDC.

Our main analysis uses only foundation doctors to quantify the unsocial work pattern of NHS organizations because, during their foundation years, trainee doctors are subject to rotas across hospital organizations over which they can exert a very limited choice, if any (see Section 2.2). This approach protects our analysis from the self-selection bias that would arise if it was possible to choose the medical specialty and the hospital organization for the foundation years rotations freely, as the amount of unsocial work required is heavily determined by the specialty departments which trainees get assigned to (see Appendix Figure A.8). This fact is corroborated by Table 3, which presents balance tests for demographic characteristics between two subgroups of trainee doctors, allocated depending on whether their treatment exposure level lies below or above the median sample value (i.e. 0.418).

The top two panels of Figure 2 show that, following the phased implementation of the 2016 TDC – which was completed only in August 2017 – foundation trainees working in hospital organizations with an unsocial work exposure above the median level experienced a pronounced reduction in their total pay, driven exclusively by a reduction in their unsocial work hours pay, whereas the gap in basic pay remained stable around zero as in the pre-2016 period. Finally, Figure 3 plots the distribution of the treatment exposure variable. Its average value is 0.428, i.e. 42.8% of the basic salary, with a 0.039 standard deviation. The vast majority of trainee doctors records a treatment exposure value between 40% and 50% of the basic salary, respectively corresponding to Bands 1b and 1a in Table 2.

4.3 Empirical Strategy

To study whether the pre-TDC exposure to unsocial work is associated with a post-contract increase in the trainee doctors' leaving rate, we estimate the following linear probability model (LPM)[26]:

$$L_{iht} = \theta_1 C_t + \theta_2 (C_t * UNS_i) + \beta X_{it} + \alpha_i + \pi_{ht} + \epsilon_{iht}. \tag{6}$$

L_{iht} is an indicator variable equals to 1 if trainee doctor i leaves hospital organization h in month t (for reasons other than death or maternity) and does not reappear in the ESR in the subsequent 6 months. C_t is a dummy for the post-contract period, taking the value of 1 from August 2016 onward. UNS_i is the continuous treatment exposure variable defined in Section 4.2. In this quasi DiD setting, the coefficient of interest, θ_2, measures the effect of the pre-contract exposure to unsocial work on the probability of leaving the NHS after the introduction of the 2016 TDC, provided that the parallel trends assumption holds across all different levels of UNS_i.

We also separately investigate whether the 2016 TDC affected the decision to leave the NHS medical training permanently or temporarily. To do so, we define respectively: a permanent leave indicator, PL_{iht}, taking the value of one if trainee doctors disappear from the ESR for more than 13 months; and a training break dummy, TB_{iht}, whenever a trainee doctor disappears from the ESR registry for a period ranging from 7 to 13 months, in order to accommodate the large number of trainee doctors that take a sabbatical before moving into specialty training (Rimmer, 2017; Torjesen, 2018; Rimmer, 2019).[27]

The set of covariates, X_{it}, includes several controls for potential confounding, which might correlate with both trainees' attrition and the exposure to unsocial working hours. It contains: a polynomial of degree two in age; binary variables controlling for the period when trainee doctors went on strike against the new contract (from January to April 2016). Furthermore, X_{it} includes the interactions between binary variables controlling for the trainees' medical area of specialization in a given month and indicators for the four different grades of the trainee doctor training: Foundation Year 1, Foundation Year 2, Specialty Registrar

[26] The large sample size, coupled with the presence of high-dimensional fixed effects, does not allow the model to be estimated with nonlinear models for binary outcomes such as logit or probit.

[27] As we observe an unbalanced panel of individuals, with new trainee doctors entering the sample in each year, it is necessary to define the employment attrition outcomes for all trainees with respect to a common duration criteria, e.g. being missing from the sample for at least 13 months for the permanent quits indicator. Otherwise, without truncating the attrition from above, the employment attrition outcomes of trainee doctors entering the sample in different years, e.g. 2010 and 2015, would not be comparable, because the 2010 trainees would have a longer period (8 years) than the 2015 trainees (3 years) to exit the sample.

(first to third year) and Specialty Registrar (fourth to eight year); these interactions allow us to control for the compound, nonlinear effects of training in certain medical specialties on the decision to quit the NHS. X_{it} also includes the interactions between the aforementioned four trainee medical grade categories and binary indicators for the twelve calendar months of the year, in order to capture the different seasonal attrition patterns at various stages of the trainee doctors' training (see Appendix Figure A.9).[28]

Equation 6 includes individual fixed effects, α_i, controlling for unobserved time-invariant trainee-level factors that may correlate with the decisions to leave the NHS. Their inclusion reduces the risk of omitted variable bias in the estimates of interest due to time-invariant unobserved heterogeneity. However, we also experiment with the exclusion of α_i from the various model specifications.[29] Instead, π_{ht} are binary variables for the hospital organization h in which trainee doctor i is employed at time t; these dummies serve to account for unobserved labour supply and demand factors that might correlate with the trainee doctors' attrition at the hospital organization level and over the course of trainee doctors' employment in the NHS. Finally, ϵ_{iht} is the error term, assumed to be correlated among trainee doctors that are part of the same training programme. For this reason, Equation 6 is estimated using OLS and with standard errors clustered according to the first NHS hospital organization joined by each trainee doctor.

Identification. The identification of the coefficient of interest, θ_2, stems from the variation in the amount of unsocial work related to trainee doctors' rotations across hospital organizations and medical specialties over time. As explained in subsection 2.2, trainees may express preferences over which medical specialties to rotate - apart from the compulsory rotations in General Medicine and Surgery - but they cannot exert a choice about which hospital organization (within their Foundation School network) they will undergo a given specialty rotation.[30] Thus, two trainee doctors in the same Foundation School might rotate in the

[28] Appendix Figure A.9 shows that an increasing number of trainee doctors decides to quit the NHS or take a training break after terminating their foundation programme. For instance, the share of FY2 doctors that left the NHS for at least 7 months in July 2018 was around 40%.

[29] In the specification without individual fixed effects, we control for individual-level heterogeneity by including the following time-invariant control variables: dummies for the first NHS hospital organization of employment; gender; nationality; ethnicity; cohort of entry into the NHS.

[30] Even when trainees actively choose some of the specialties where they rotate, this self-selection does not affect our results: our sample of trainees includes only those who were admitted to Foundation School up to the year 2015 intake, we measure UNS_i only in the period before the new contractual terms were applied, and before January 2016 the new TDC terms penalizing unsocial hours pay were not known. Hence, trainees could not have self-selected into specialties based on expected gains from the new contractual terms. Moreover, the inclusion of trainee fixed-effects α_i in our preferred specification removes any source of trainee-specific confounding due to unobservable and time-invariant 'taste for unsocial medical specialties' that is systematically correlated with the propensity to leave the NHS.

same combination of medical specialties during their foundation training, but in two different hospital organizations and at different times. The variation over time in terms of resources, staff employed and healthcare demand from patients across different hospital organizations eventually determine the amount of unsocial working hours demanded from trainees. Hence, regardless of the inclusion of trainee fixed-effects α_i, Equation 6 identifies the change in the effect of unsocial working hours, UNS_i, on attrition in the post-2016 contract period, based on the rotations of trainee i across a series of hospitals $h = 1, .., H$ and conditional on the included interactions between trainee grades and specialties, and trainee grades and calendar months of the year.

5 Results

5.1 Descriptive statistics

Summary statistics for the main variables of interest are provided in Appendix Table A.1. They are calculated for the period between January 2010 and July 2016, i.e. the "pre-contract period", and separately for each trainee doctor training stage. The first two rows of Table A.1 confirm how - under the 2002 contractual terms - the average trainee doctor used to earn approximately 40% of the basic salary as additional compensation for unsocial work. The average monthly probability of leaving the NHS (defined in Section 4.3 and denoted by Leave) was about 2% during the pre-contract period. Moreover, it was relatively low (high) for Foundation Year 1 (Foundation Year 2) doctors. Not surprisingly, the vast majority of medical trainees is British, followed by overseas and European trainees. Finally, females account for the majority of trainee doctors (58% on average), aged around 27 years old.

5.2 Pre-reform association between unsocial work pay and pay satisfaction

To investigate whether trainee doctors place different values on alternative sources of income, we extract all trainee doctors' NSS records from 2009 to 2015 (i.e. the pre-reform period) and, based on the individual trainee doctors' hospital organization of employment in each year, we match the pseudonymized survey responses with the average trainee doctor's basic salary and unsocial work earnings at the hospital level. The NSS item of interest in this section is a question about the trainee doctors' satisfaction with pay, which is expressed on a Likert scale from 1 (very unsatisfied) to 5 (very satisfied). For this reason, we estimate ordinal logit regressions (including hospital fixed effects) linking trainee doctors' pay satisfaction to

the two aforementioned main hospital-level pay components.

The results of this exercise are reported in Table 4. According to the displayed logit odds ratios, pay satisfaction is more sensitive to unsocial work earnings than basic salary. Specifically, an additional £100 in unsocial work earnings increase trainee doctors' satisfaction with pay by 7.9%, whereas the estimated effect of an equivalent basic salary rise is statistically indistinguishable from zero (see Column 1). As modelled by our conceptual framework, this finding is consistent with the hypothesis that trainee doctors attribute a high value to the work provided during unsocial hours or its opportunity-costs (Maestas et al., 2023), and potentially suffered a disutility from the devaluation in their unsocial hours pay brought by the 2016 contract (Lazear and Shaw, 2007). In further support of this claim, the odds ratios reported in Column 2 of Table 4 show that the opportunity cost of unsocial shifts is higher among female trainee doctors. Based on these findings, we can now examine whether higher pre-policy exposure to unsocial work translated into higher attrition from the English NHS following the 2016 contractual reform, therefore testing H2 of our conceptual framework.

5.3 The effect of the 2016 contract on trainee doctors' attrition

Table 5 reports the estimates of our coefficient of interest, θ_2, from the quasi DiD Equation (6), first without (columns 1-3) and then with (columns 4-6) the inclusion of trainee doctor fixed effects α_i. They indicate that higher exposure to unsocial work in the pre-contract period was associated with an increase in the monthly probability of leaving the NHS after the 2016 contractual terms were introduced. The magnitude of $\hat{\theta}_2$ increases by about one third (0.027 versus 0.019) and the fit of the model also improves when individual fixed effects are included.

Considering that from August 2015 to July 2016 the average monthly trainee doctors' headcount in our sample is 23,835, the estimate at the mean translates into an additional loss of about 275 trainee doctors (=0.428*0.027*23,835) from the English NHS, corresponding to a 6% increase with respect to the 2015 number of quitting trainees (4,549 leavers).

The remaining columns of Table 5 indicate that the 2016 TDC primarily increased the decision to quit permanently the NHS, rather than increasing the instances of temporary breaks from the medical training: the impact of the contract is of 204 (=0.428*0.020*23,835) TDs lost, or equivalently a 6.7% increase in the number of TDs permanently leaving the NHS in the 12 months prior to the introduction of the contract (3,025 permanent leavers). Although striking, these figures are significantly lower than the trainee doctors' intentions to quit documented by NHS survey data before the approval of the 2016 contract (Kmietowicz, 2015).

We also estimate a dynamic version of Equation 6 using an event-study design, by replacing the post-contract indicator with a set of calendar year dummies. This alternative specification allows us to examine how the introduction of the 2016 contract affected trainee doctors' retention in each year around its implementation date. Moreover, it allows us to control more flexibly for a large set of common shocks that might have affected the retention of all trainee doctors included in our analysis sample, such as the unexpected result of the Brexit referendum held in June 2016, namely a few months prior to the introduction of our policy reform of interest. The estimated coefficients are shown by Figure 4, whereas the point estimates are reported in Appendix Table A.2. In all years following the introduction of the 2016 contract, higher exposure to unsocial work is associated with an increase in the likelihood of leaving the NHS. This effect appears to peak in 2017, when the new 2016 contractual terms were fully in place and its transitory phase had expired. Furthermore, the interaction terms over the pre-2016 period are statistically indistinguishable from zero, providing support to the plausibility of the parallel trend assumption.

5.4 Falsifications tests, robustness checks and heterogeneity

Falsification tests. To validate the main findings discussed in subsection 5.3, we perform a series of falsification tests using four alternative estimation samples. First, we verify whether our measure of exposure to unsocial work explains the post-contract probability of leaving the NHS of a group of senior doctors with an age profile similar to trainee doctors, but not subject to the 2016 change in their national contractual terms. We construct both a monthly panel of 7,133 senior doctors with up to 5 years of experience in a hospital consultant grade and a separate panel of 5,654 associate specialist and specialty (SAS) doctors. Both these hospital physician categories represent the natural professional progression of a NHS trainee doctor.

The senior doctors' monthly ESR records are matched with the median share of unsocial supplement pay among foundation doctors in the same hospital organization where senior doctors are employed. We then compute the pre-reform exposure UNS_i as the average of these monthly median values for each senior doctor in each of the aforementioned two categories. We then estimate our baseline specification, Equation 6, using these alternative samples. The results, reported in Panels A and B of Table 6, show that the pre-contract exposure to unsocial work did not affect the likelihood of leaving the NHS for either group of early-career senior hospital doctors. Moreover, most of the θ_2 estimates are negatively signed. These conclusions are also confirmed by the event-study estimates of these falsification exercises, which are displayed in Appendix Figure A.10 and Figure A.11.

Panel C of Table 6 provides the results for another set of falsification tests, in which we backdate the trainee doctors' contract change date: we estimate Equation 6 on a sample of trainee doctors from January 2010 to December 2015, with the post-contract period spanning from August 2013 to December 2015. For consistency, the treatment exposure variable of these specifications is respectively defined on the alternative placebo pre-contract period (i.e. from January 2010 to July 2013). Once again, we find no significant effect of the 2016 TDC on NHS trainees' attrition. This appears clearly even from the event-study estimates reported in Appendix Figure A.12. Overall, the falsification exercises discussed in this section confirm that our baseline analysis identifies the effect of the 2016 contract on trainee doctors' retention, rather than that of unsocial work exposure per se.

Hours worked. We also check whether our results could be explained by the different intensity of the workload that trainee doctors were exposed to before August 2016, rather than its unsocial degree. As mentioned in Section 4.2, the amount of unsocial income earned up to August 2016 was related not only to unsocial work shifts, but also to the number of additional hours worked (see Table 1 and Table 2). To assess this potential confounding effect, we define the variable $Hours_i$ by following the same approach described in Section 4.2 for defining UNS_i. Thus, $Hours_i$ measures the pre-contract work intensity that trainee doctors experienced until August 2016, by using the amount of hours worked by hospital organization peers at the foundation training stage. Then, the interaction between this continuous variable and the 2016 contract dummy is included in Equation 6 as an additional control, to capture the effect of work intensity on trainee doctors' attrition rates.

The results of this specification are provided in Appendix Table A.3. The coefficients for the added work intensity proxy are statistically significant across all columns, but negative. This might be explained by a higher attachment to work (thus fewer NHS leavers) in hospital organizations characterized by high intensity of work. The fact that the coefficient of interest θ_2 remains statistically significant and in line with the main estimates in Table 5 reassures that the effect of interest on trainees' attrition from the NHS is not driven by the intensity of their working schedule.

Confounding due to the 2016 Brexit referendum. Another possible concern related to our findings is whether the θ_2 point estimates reported in Table 5 are confounded by the effects of the June 2016 Brexit referendum, which occurred right before the implementation of the 2016 Trainee Doctor Contract. While in principle it is impossible to rule out such contamination, we present two robustness checks for this potential confounding factor. We exploit official data on the Brexit referendum outcome, using the postcode location of each

NHS hospital organization to match the trainee employment records to the local support for Brexit. Specifically, we define a variable measuring the support for Brexit (i.e. the share of votes for leaving the EU) in the voting area where each NHS hospital organization is located; then, we average the Brexit support variable over all individual employment records up to June 2016, by exploiting the fact that trainee doctors rotate across different NHS hospitals. This variable quantifies the exposure to pro-Brexit areas that each trainee doctor was subject to, prior to the Brexit referendum.

In the first instance, we estimate an augmented version of Equation 6 by including the interaction between a post-Brexit dummy and the Brexit support exposure as an additional control. The results of this specification are provided in columns 1-3 of Appendix Table A.4, Panel A. While the estimated coefficients indicate that the probability of leaving the NHS permanently (temporarily) has increased (decreased) since June 2016 for trainee doctors who rotated across many pro-Brexit areas, the estimates of the quasi-DiD coefficient of interest θ_2 are almost identical to those in Table 5. In columns 4-6, we refine this analysis by exploring whether the effect of the Brexit referendum on trainee doctors' leaving rate differed not only according to the individual exposure to the support for the Brexit cause, but also by trainee doctors' nationality, as it is reasonable to expect that the outcome of the referendum was more relevant for European doctors. Indeed, the results show that European trainee doctors employed in pro-Brexit areas increased their permanent attrition from the NHS after the 2016 referendum, consistently with what reported in the medical literature (Borchert et al., 2017; Chick and Exworthy, 2018; Milner et al., 2021). Even in this case, both the magnitude and the statistical significance of the estimates of θ_2 are similar to Table 5.

In Panel B of Table A.4, instead, we provide a falsification test, obtained by replacing the interaction term between the post-contract dummy and the unsocial work exposure with the Brexit exposure variable included as a control in Panel A. In this case, the Brexit-related coefficients are very small in magnitude and not statistically significant, confirming that our baseline estimates are unlikely to be confounded by the Brexit referendum.

Heterogeneous impacts by trainee gender. By reducing the pay for unsocial working hours, the 2016 Trainee Doctor Contract had been criticized prior to its approval for the possibility to disproportionately affect female trainees (Harries et al., 2015; Rimmer, 2015, 2016). The provision of work during unsocial hours has evident opportunity costs with respect to caring duties for either children or the elderly, which are more frequently performed by women (Foley et al., 2023). To test this hypothesis, we estimate Equation 6 separately for male and female trainee doctors.

The key findings, summarized by Appendix Figure A.13, suggest that female trainee

doctors were indeed more likely to leave the NHS when exposed to more pre-reform unsocial work, after the introduction of the 2016 contract: the θ_2 point estimate is 0.035 for female trainees and 0.018 for male ones (see panel A of Figure A.13).[31] This difference, however, appears primarily driven by the decision to take a break from the NHS medical training (see panel C of Figure A.13). A Wald test between the male and female DiD interactions in a fully-interacted model by gender of our baseline specifications rejects the null of equal effects on the likelihood of a career break, whereas we do not find any statistically meaningful difference in terms of the probability of a permanent quit.

In Panel B of Appendix Table A.5, we further analyze these gendered effects by interacting the effect of interest with a dummy for part-time employment, which takes value one if the mode of trainee doctors' appointment in the pre-contract period was a part-time position; the results do not document notable differences between full-time and part-time trainee doctors, as the coefficient of interest interacted with the part-time dummy is not significant.[32]

Additional analyses. The identification strategy outlined in sub-section 5.3 relies on two main assumptions. First, it requires parallel trends to hold across the distribution of UNS_i during the entire pre-contract period. Intuitively, this condition imposes that exposure to unsocial work should not be correlated with trends in trainee doctors' attrition. Second, it assumes that trainee doctors highly exposed to unsocial work prior to the 2016 reform were more penalised by the new contractual terms. This section provides further evidence in support of these assumptions, by reporting the results of two specifications that use only pre-treatment employment records.

Appendix Table A.6 displays the estimates of a linear specification in which the individual exposure to unsocial work is interacted with either a monthly (Panel A) or a yearly (Panel B) time trend. None of the interactions terms is statistically significant. This finding shows that exposure to unsocial work during the pre-contract period was not correlated with trends in NHS attrition rate, thus providing evidence in support of the parallel trend assumption on top of Figure 4.

Appendix Table A.7 reports estimates of a linear specification testing the association between the amount of unsocial earnings as a share of basic pay during the foundation training years and the same pay measure during the first year of specialty training. Columns 1 and 3 show a significant association in the pay for unsocial work across different stages of the doctor training. An even stronger association is documented for hours worked across these two periods (Columns 2 and 4). These findings are suggestive of the persistence in working

[31] The point estimates are provided in Panel A of Appendix Table A.5.
[32] The part-time sample excludes trainee doctors on parental leave, recorded by the ESR as part-time trainees.

patterns from the foundation training period to the medical specialization period. Indeed, it is likely that a substantial share of trainee doctors originally assigned to specialties with more unsocial work continue their training in such specialties even after the foundation years, or they would otherwise risk losing (or, at the very least, not putting to fruition) the human capital related to the specific on-the-job training that they acquired. Consequently, trainee doctors who were particularly exposed to unsocial work under the 2002 trainee contract might have been more penalised, or might have reasonably felt to be more penalised in the near future, by the introduction of the 2016 contractual terms, which would explain the existence of a scarring or outrage effect that increased trainee doctors' attrition from the NHS.

5.5 Mechanisms: pay satisfaction and intentions to quit

To understand the behavioural mechanism explaining the post-2016 contract increase in the trainee doctors' leaving rate, we further exploit data from the annual NHS Staff Survey (NSS) and test whether and to what extent the introduction of the 2016 pay terms were satisfactory for trainee doctors employed by hospital organisations with different unsocial work demands (H3 of our conceptual framework).

To conduct this exercise, we extract all trainee doctors' NSS records from 2009 to 2019 and, again based on the trainee doctors' hospital organization of employment in each year, we match the survey responses with the foundation doctors' median share of unsocial work earnings between August 2015 and July 2016.[33] We then reestimate an ordinal logit model for pay satisfaction (including hospital organization fixed effects) with an interaction term between the proxy for the hospital-level amount of unsocial work described above and a post-reform dummy (valued one from 2016 onwards), as the main covariate of interest.[34]

The results of this exercise are reported in Column 1 of Table 7. The odds ratio associated with the DiD interaction term is smaller than 1 and statistically significant. Hence, trainee doctors' satisfaction with pay significantly decreased after the introduction of the 2016 contract in hospital organisations with more unsocial work. This finding is further supported by the remaining estimates reported in Table 7, which - similarly to the results discussed in subsection 5.4 - consists of a series of falsification tests. In Column 2, the pay satisfaction

[33] For those hospital organisations that did not have any foundation doctor over the 12-month window prior to the introduction of the 2016 contract, we compute the median share of unsocial work earnings of the specialty doctor trainees employed there.

[34] The model also controls for trainee doctors' gender and age, respectively using a female dummy and 3 age group dummies for being younger than 31, aged 31-40 and older than 40; the estimation sample excludes trainees with missing information on gender and age, resulting in a loss of 1,776 observations (3.8% of the total).

outcome is measured from the universe of senior doctors who responded to the NSS. Instead, Columns 3 and 4 provide results on the effects of the 2016 contract on trainee doctors' pay satisfaction using two alternative placebo contract change dates; this analysis uses a sample of NSS records from 2009 to 2015, i.e. the pre-contract period: the post-contract period is defined as the years from 2012 to 2015 in the model reported in Column 3, and as the years from 2013 to 2015 in the analysis summarised in Column 4. The value of the hospital organization exposure thus changes accordingly, as it always gets computed in the 12 months prior to the placebo treatment date (i.e. from August 2011 to July 2012 in Column 3 and from August 2012 to July 2013 in Column 4). None of these three falsification checks results in statistically significant effects on pay satisfaction.

Since 2018, the NSS data include also detailed information on NHS hospital workers' intention to quit either the NHS or the hospital organisation where they are employed, which allows us to study how the introduction of the 2016 contract affected TDs' intentions to quit their jobs. For this sake, we use the 2018 cross-sectional NSS data at individual doctor level to investigate how the intention to quit the current employment correlates with both pay satisfaction and the amount of unsocial work that was typically carried out at the hospital prior to the 2016 reform. Column 1 of Table 8 reports a significantly negative association between the TDs' intention to look for a job in a new organisation in the next year and a binary variable equal to one when a TD is either satisfied or very satisfied with the level of pay. As shown by the coefficient reported in Column 2 of Table 8, the intention to look for a new job over the next 12 months is positively associated (significant at 10%) with the amount of unsocial work provided to the hospital organisation in the 12 months prior to the introduction of the 2016 contract. Furthermore, Column 3 shows that the positive association between unsocial work and the intention to look for a new job is stronger in magnitude and more precise for TDs who were consecutively employed by the same hospital organisation for longer than one year.[35]

Finally, the last three columns of Table 8 provide the results of a multinomial logit regression investigating the desired employment destinations for the TDs who considered leaving their current job, as a function of the amount of unsocial work provided at each hospital organisation before the introduction of the 2016 contract. The estimates are reported in three different columns (4a-4c), but they are produced from the same multinomial logit regression having the group of trainees who did not consider leave the NHS hospital sector

[35]By splitting the 2018 trainee doctors based on the length of their tenure we are able to identify a subgroup of TDs who, during the transition to the new national contract – between August 2016 and August 2017– were likely still employed by the same hospital organisation for which their pre-reform exposure to the 2016 contractual terms is measured, as opposed to a subgroup of TDs who joined the employer hospital organisation in 2018, following a scheduled training rotation.

in 2018 as the reference outcome category.[36] According to the estimates, more unsocial work prior to the 2016 reform means higher intention to quit the current job and to leave the healthcare sector completely, especially among those trainees that in 2018 were employed by the same hospital organisation for longer than one year (Column 4b). For the same subgroup of trainees, unsocial work is positively associated also with the intention to take a career break, although this effect is not statistically significant (Column 4a). Overall, the analyses provided in this section suggest that the 2016 contractual terms for NHS TDs reduced pay satisfaction in hospital organisations where unsocial work was more common; in turn, it is likely that the decreased pay satisfaction increased TDs' intention to quit their current employment and to look for a job outside healthcare.

6 Conclusions

Setting an optimal pay structure is critical for the smooth delivery of quality public healthcare services. Organizations need to decide about the compensation package they should offer to their employees, while both securing their effort and meeting their participation constraints (Dixit, 2002).

In this paper, we exploit a reform that restructured the pay structure of the work shifts of English NHS hospital trainee doctors. The new national contract implemented in August 2016 severely reduced their pay for work provided during unsocial work shifts, which are frequent and a necessary work commitment for physicians who choose to pursue a career within hospital care. Our analysis is among the first to provide evidence on the impact of this reform on trainee doctors' attrition from the NHS and their pay satisfaction, with a micro-foundation based on the doctors' reference-dependent preferences on work pay.

Pay terms that lower the compensation for unappealing job aspects, such as unsocial work shifts, are known to affect both the decision to quit and the performance of workers (Lazear and Shaw, 2007). Consistently, our estimates suggest that the introduction of the new contract caused a significant increase in the probability to quit the NHS, i.e. a 6.7% increase with respect to the figures in the year before the reform, which translates into an additional loss of 275 trainee doctors – 204 of whom permanently quit the NHS. These results are robust to various model specifications and falsification tests. Moreover, we show that this attrition effect most likely stems from a significant reduction in the pay satisfaction of NHS trainee doctors, induced by the 2016 contractual terms, which ultimately also

[36] The reference category of the multinomial logit regression reported in Columns 4a-4c of Table 8 is made by TDs who either do not consider leaving their job at all or who consider leaving their job for a new job either in the same or in a different NHS hospital organisation.

increased NHS trainee doctors intentions to quit their current job and switch to alternative occupations outside healthcare.

Given the ongoing shortage of healthcare workers, in the English NHS as well as in the healthcare systems of many other developed countries, our findings carry significant potential learnings and the following policy implications.

First, Pay structure and its different components compensating work shifts of different nature matter for the retention of public (hospital care) workers, such as trainee hospital doctors. Since job attrition and satisfaction among skilled workers in the early stages of their careers, such as trainee doctors, are responsive to changes in working conditions, improving pay and contractual conditions for this group could help incentivise recruitment of new aspiring doctors and reduce the risk of medical personnel shortages.

Second, the assumption that workers' expected utility is derived only by the level of the total pay package is simplistic and potentially naïve. Workers may have heterogenous preferences for, and derive different utilities from, each category of contractual tasks regulated by an employment relations agreement. Managing employee expectations before contractual changes should be a crucial aspect of policymaking, according to our theoretical model, as expectations serve as reference points that directly affect utility. When changes fall short of expectations in some component, workers may suffer a utility loss even though their total pay increases.

Third, there is also potentially considerable scope for policy-making improvements in the contractual agreement reform processes setting the wages of public (NHS hospital) workers through the use of publicly available data. Ahead of the 2016 contract imposition, NHS healthcare policy-makers could have used the NHS Staff Survey and Electronic Staff Records data to ascertain the relationship between trainee doctors' unsocial work pay and their pay satisfaction. Had this been done, the importance of unsocial work pay for NHS trainee doctors' pay satisfaction, and the consequent need to limit cuts to such pay component, would have been more evident.

Finally, despite the empirical results in this article being specific to the NHS and its trainee hospital doctors, the main learnings from this work – that is, the workers' response to an unfavourable change in their contractual employment conditions due to their reference-dependent preferences – may be generalisable also to other categories of skilled public sector workers, such as school teachers, IT and diplomatic service officers, government lawyers and engineers, or private sector employees of large firms adopting collective employment agreements.

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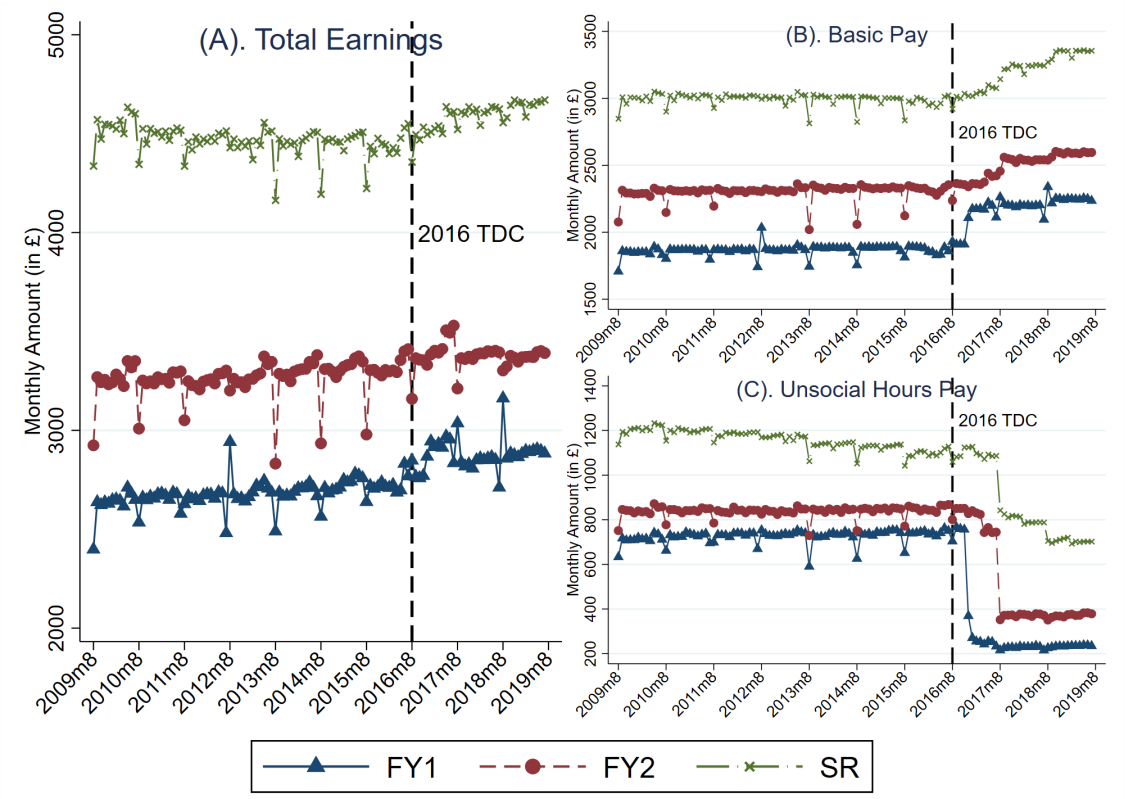
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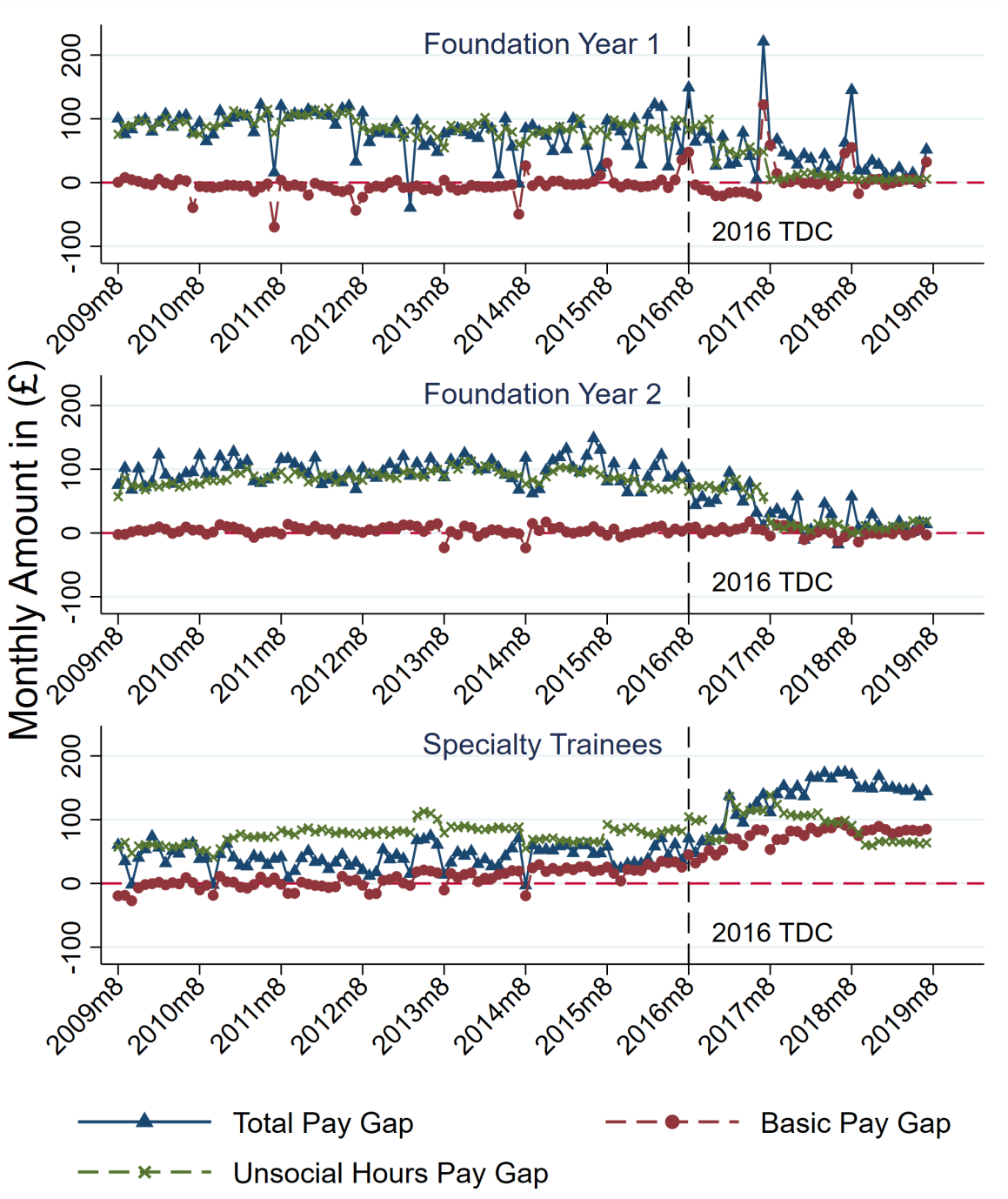
Main Figures and Tables

Figure 1. Monthly trainee doctors' total earnings, basic pay and unsocial hours pay



Notes. Authors' calculation from the Electronic Staff Records (ESR), using data for all NHS trainee doctors between August 2009 and July 2018. 2016 TDC = official starting implementation date of the 2016 Trainee Doctor Contract. FY1 = Foundation Year 1; FY2 = Foundation Year 2; SR = Specialty Registrar.

Figure 2. Pay level gaps by level of hospital unsocial hours work and medical training stage



Notes. Earnings gap is the difference in the average monthly salary pay between NHS trainee doctors rotating in high unsocial work hospitals and low unsocial work hospitals, reported by the phase of their medical training stage, the salary components (basic pay and unsocial pay, separately) and total pay (the sum of basic and unsocial pay). High (low) unsocial work hospitals are defined as those with a pre-2016 contract share of unsocial pay among foundation doctors above (below) the sample median.

Figure 3. Treatment (unsocial work) exposure distribution

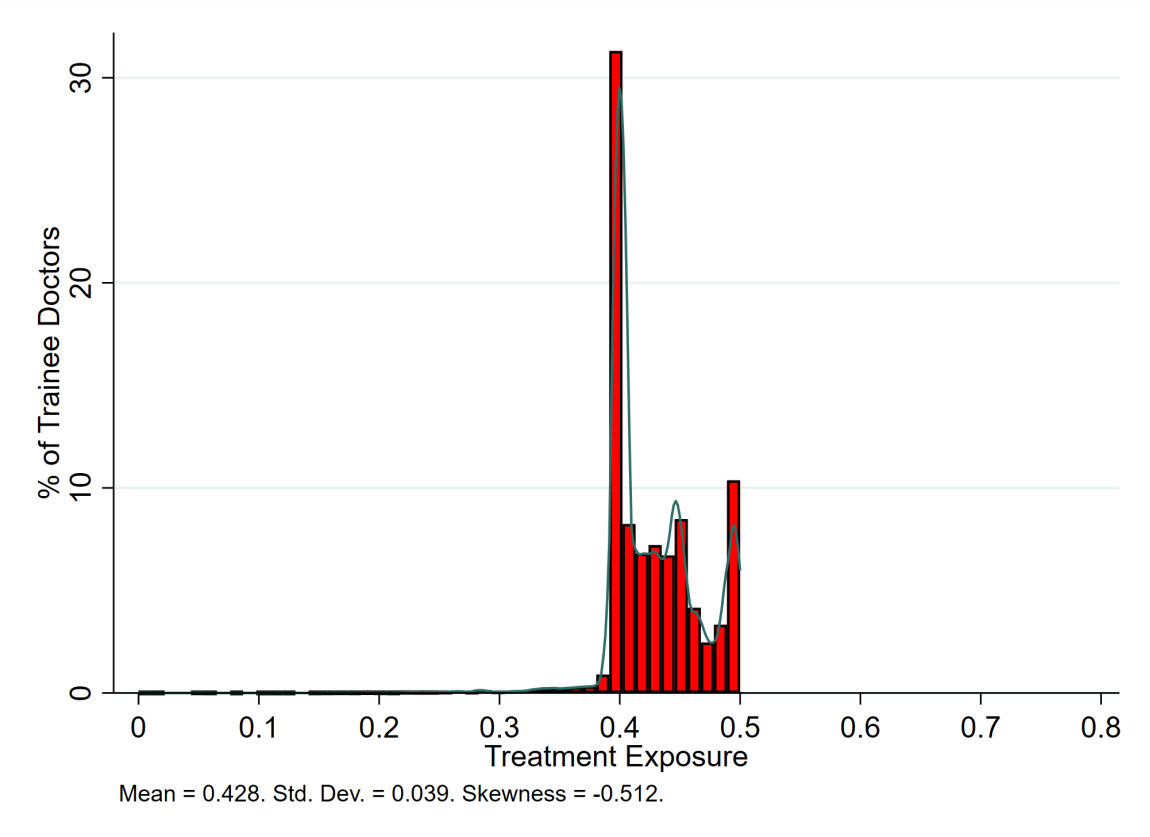


Figure 4. The effect of the 2016 contract: event-study estimates

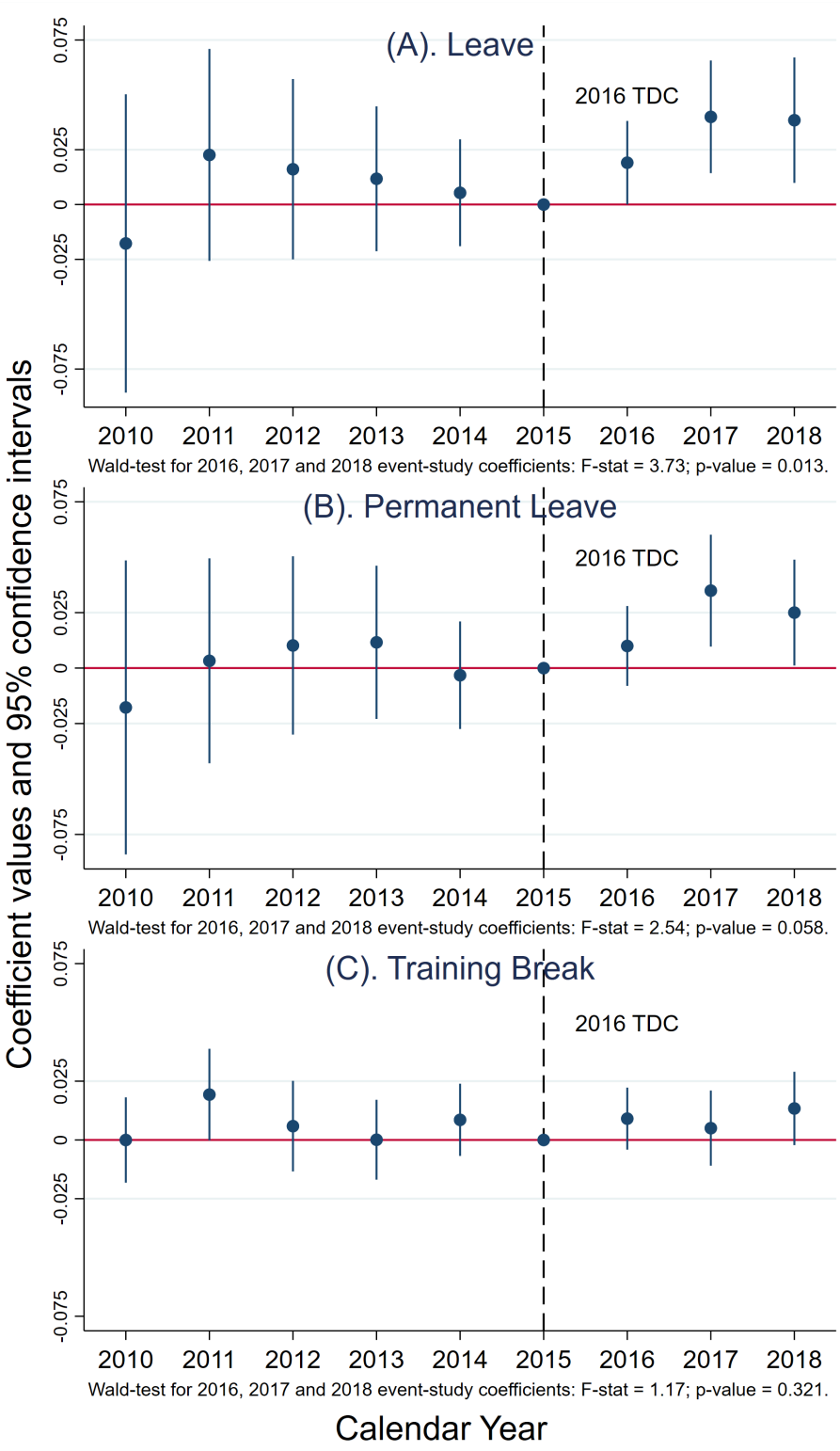


Table 1. Comparison of 2002 and 2016 NHS trainee doctor contractual terms

Pay components	**2002 contractual terms**	**2016 contractual terms**
Changes with respect to 2002 contract Basic Salary	-	10%-11% Basic Salary increase, but down from initially promised 13.5% increase
Allowance for weekend work	maximum of 2.0 × basic monthly pay for overall work (i.e. normal shifts plus unsocial hours shifts)	maximum of 1.15 × basic pay rate for 1 shift each 2 weekends
Allowance for night shifts (11pm - 6 am)	1.5 × basic pay rate	1.37 × basic pay rate
Allowance for *additional hours*	1.2 × basic pay rate	1.0 × basic pay rate

Notes. In the NHS, *unsocial hours* are defined as work shifts during weekend days (Saturday and Sunday) or nights (11pm - 6 am), whereas *additional hours* are the number of hours worked in addition to a 40-hour week and that are neither weekend nor night shifts (see also `https://www.bmj.com/careers/article/the-complete-guide-to-nhs-pay-for-doctors`).

Table 2. Unsocial Hours Pay Supplement as a % of Basic Salary (2002 contract)

Band	Hours Worked	Unsocial Degree	Pay Supplement as % of Basic Salary
Band 3	$>$ 56 hours a week		100%
Band 2a	48-56 hours a week	1 weekend in 3	80%
Band 2b	48-56 hours a week	less than 1 weekend in 3	50%
Band 1a	41-47 hours a week	1 weekend in 4	50%
Band 1b	41-47 hours a week	less than 1 weekend in 4	40%
Band 1c	41-47 hours a week	low frequency non-resident on call	20%
No band	$<$ 41 hours a week		0%

Table 3. Balance Table

	Below median exposure (1)	Above median exposure (2)	t-test (1)-(2)
Hours (1^{st} year of training)	42.655	42.879	-0.223
	(0.148)	(0.081)	
Earnings (1^{st} year of training)	2,622.794	2,709.865	-87.071***
	(16.150)	(12.282)	
Hours (August 2017-July 2018)	41.208	41.258	-0.050
	(0.092)	(0.138)	
Earnings (August 2017-July 2018)	4,329.583	4,421.019	-91.436***
	(23.416)	(18.186)	
Age	25.436	25.423	0.013
	(0.062)	(0.057)	
Female	0.587	0.580	0.006
	(0.006)	(0.005)	
BAME	0.294	0.285	0.009
	(0.014)	(0.012)	
British	0.826	0.812	0.015
	(0.011)	(0.017)	
European	0.051	0.052	-0.002
	(0.002)	(0.003)	
Overseas	0.085	0.077	0.009*
	(0.006)	(0.004)	
Cohort 2009	0.136	0.135	0.001
	(0.006)	(0.005)	
Cohort 2010	0.141	0.144	-0.003
	(0.006)	(0.005)	
Cohort 2011	0.149	0.148	0.001
	(0.007)	(0.005)	
Cohort 2012	0.125	0.133	-0.008
	(0.006)	(0.005)	
Cohort 2013	0.147	0.150	-0.003
	(0.005)	(0.004)	
Cohort 2014	0.135	0.156	-0.021*
	(0.007)	(0.007)	
Cohort 2015	0.167	0.134	0.032
	(0.011)	(0.011)	

Notes: Summary statistics and balance tests comparing low exposed (below median) and high exposed (above median) trainee doctors to unsocial work. BAME = Black, Asian or other ethnic minorities. Standard errors are clustered by the first NHS hospital organization entered by trainee doctors. Significance levels: * 0.1; ** 0.05 *** 0.01.

Table 4. Pay satisfaction from different income sources

	Pay satisfaction	
	(1)	(2)
HO Basic Salary	0.942	
	[0.875,1.014]	
HO Unsocial Hours Pay	1.079***	
	[1.026,1.135]	
HO Basic Salary * Male		0.941
		[0.870,1.019]
HO Basic Salary * Female		0.942
		[0.876,1.013]
HO Unsocial Hours Pay * Male		1.052*
		[0.997,1.110]
HO Unsocial Hours Pay * Female		1.103***
		[1.044,1.165]
N * T	14,523	

Notes: Ordinal logit odds ratios measuring the trainee doctors' pay satisfaction from different income sources. The model is estimated at the individual level, using 2009-2015 trainee doctors' records from the NSS. The hospital-level variables (basic salary and unsocial hours pay) are computed as the yearly averages of all trainee doctors' employed in the hospital, using the payslip records from the ESR. The model includes hospital-level fixed effects. Standard errors are clustered at the hospital level. 95% confidence intervals are reported in brackets. Significance levels: * 0.1; ** 0.05 *** 0.01.

Table 5. Effect of the 2016 contract on trainee doctors' attrition from the NHS

	(1)	(2)	(3)	(4)	(5)	(6)
	L	PL	TB	L	PL	TB
2016 Contract	-0.009***	-0.007***	-0.002	-0.010***	-0.010***	0.000
	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)
2016 Contract * Unsocial Work Exposure	0.019***	0.013**	0.005	0.027***	0.020***	0.007
	(0.006)	(0.006)	(0.004)	(0.008)	(0.007)	(0.005)
N		40,954			40,954	
N * T		1,761,537			1,761,537	
Individual FE	✗	✗	✗	✓	✓	✓
R-squared	0.187	0.107	0.082	0.216	0.140	0.108

Notes: L = Leave the ESR for more than 6 months. PL = Leave the ESR for more than 13 months. TB = Leave the ESR for a period ranging between 7 and 13 months. The sample goes from January 2010 to December 2018 and is made of only trainee doctors joining the NHS as Foundation Year 1 under the 2002 contractual terms (i.e. Cohorts 2009-2015). All specifications include: hospital organization fixed effects; interactions of trainee grade categories and calendar month fixed effects; interactions of trainee grade categories and medical specialty fixed effects; a binary variable valued one between January and June 2016 (i.e. trainee doctors' strikes); a polynomial of degree two in trainee doctors' age. The specifications without individual fixed effects (columns 1-3) also include a series of dummy variables controlling for: the first NHS hospital organization entered by trainee doctors; gender; nationality; ethnicity; NHS cohort of entry. N denotes the number of trainee doctors used in the estimation. $N * T$ is the overall number of monthly trainee doctors' records used in the estimation. Standard errors clustered by the first NHS hospital organization joined by trainee doctors are reported in parenthesis. Significance levels: * 0.1; ** 0.05 *** 0.01.

Table 6. Falsification tests for the 2016 contract effects on TDs' NHS leaving decision

	(1)	(2)	(3)
	L	PL	TB
Panel A: Hospital Consultants			
2016 Contract	0.003	0.001	0.001
	(0.003)	(0.003)	(0.001)
2016 Contract * Unsocial Work Exposure	-0.005	-0.003	-0.003
	(0.007)	(0.007)	(0.002)
N		7,133	
N * T		288,387	
R-squared	0.107	0.108	0.069
Panel B: SAS doctors			
2016 Contract	0.003	0.003	0.000
	(0.004)	(0.004)	(0.001)
2016 Contract * Unsocial Work Exposure	-0.005	-0.006	0.001
	(0.010)	(0.009)	(0.003)
N		5,654	
N * T		173,501	
R-squared	0.102	0.104	0.085
Panel C: Contract date			
Placebo Contract	0.005	0.006	-0.001
	(0.005)	(0.005)	(0.003)
Placebo Contract * Unsocial Work Exposure	-0.007	-0.001	-0.006
	(0.012)	(0.011)	(0.006)
N		17,452	
N * T		713,896	
R-squared	0.198	0.131	0.099

Notes: L = Leave the ESR for more than 6 months. PL = Leave the ESR for more than 13 months. TB = Leave the ESR for a period ranging between 7 and 13 months. All specifications include: hospital organization fixed effects; interactions of trainee grade categories and calendar month fixed effects; medical specialty fixed effects; a polynomial of degree two in doctors' age. Panel A and B specifications included a binary variable valued one between January and June 2016 (i.e. trainee doctors' strikes). The specifications in Panel A are estimated using a sample of senior doctors who entered a consultant post no longer than 5 years before. The specifications in Panel B are estimated using a sample of associate specialist and specialty (SAS) doctors. The specifications in Panel C are estimated using trainee doctors' ESR records from January 2010 to December 2015, using the period from August 2013 to December 2015 (columns 4-6) as placebo post-contract period. N denotes the number of doctors used in the estimation. $N * T$ is the overall number of monthly doctors' records used in the estimation. Standard errors reported in parenthesis are clustered by current NHS hospital organization (Panel A, B) or first NHS hospital organization joined by trainee doctors (Panel C). Significance levels: * 0.1; ** 0.05 *** 0.01.

Table 7. Effect of the 2016 contract on trainee doctors' satisfaction with pay

	Pay satisfaction			
		Falsification tests		
	Junior Doctors	Senior Doctors	Placebo Contract Date 1	Placebo Contract Date 2
	(1)	(2)	(3)	(4)
2016 Contract * HO Unsocial Work	0.576*** [0.383,0.867]	1.027 [0.836,1.261]	1.077 [0.465,2.494]	0.663 [0.283,1.553]
N * T	44,633	151,103	16,097	15,936

Notes. Ordinal logit individual-level model odds ratios for satisfaction with the level of pay. Unsocial work is computed as the hospital organisation's median share of unsocial work earnings among Foundation doctors (if present, otherwise among specialty trainees) over the 12 months prior to the 2016 contract reform. The sample used for the placebo contract date falsification tests goes from 2009 to 2015 included. The placebo contract date change is 2012 in Column 3 and 2013 in Column 4. Controls included but omitted from the table: an indicator variable for female trainees and three age indicator variables (younger than 30, aged 31-40, older than 40). The age controls for the senior doctors' model are the following three indicators: younger than 40, aged 41-50, older than 50. Standard errors are clustered at the hospital organisation level. 95% confidence intervals are reported in parenthesis. Significance levels: * 0.1; ** 0.05 *** 0.01.

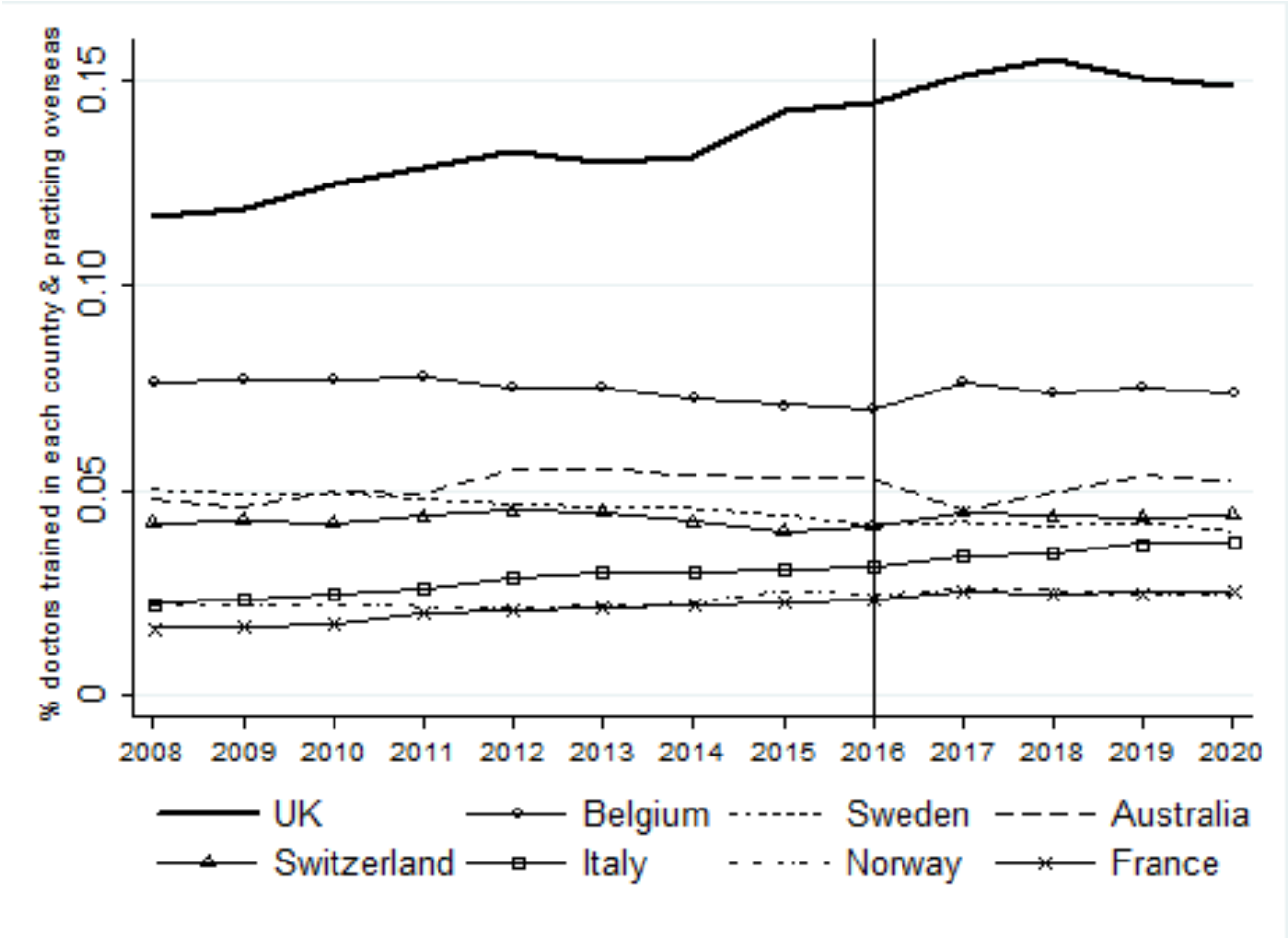
Table 8. Unsocial work, pay satisfaction and intentions to quit

	Ordinal Logit: "I will probably look for a job at a new organisation in the next 12 months"			Multinomial Logit: "If you are considering leaving your current job, what would be your most likely destination?"		
	All Junior Doctors	All Junior Doctors	All Junior Doctors by tenure	Career Break	Leavers outside health-care	Leavers towards non-NHS organisation
	(1)	(2)	(3)	(4a)	(4b)	(4c)
Satisfied with pay	0.457*** [0.422,0.495]					
Unsocial Work		2.002* [0.939,4.267]				
Unsocial Work * HO employee < 1 year			1.756 [0.792,3.896]	0.821 [0.138,4.899]	2.850 [0.390,20.848]	0.376 [0.105,1.350]
Unsocial Work * HO employee > 1 year			2.307** [1.071,4.972]	2.771 [0.436,17.617]	8.908** [1.343,59.107]	0.841 [0.237,2.981]
N * T	7,066	7,107	6,938		6,060	

Notes. Ordinal logit model odds ratios for trainee doctors' intention to look for a new job and multinomial logit estimates for trainee doctors' likely destination if considering quitting job. All models use trainee-level data for 2018 only, when NSS questionnaire items about intentions to quit become available for the first time. Unsocial work is computed as the hospital organisation's median share of unsocial work earnings among Foundation doctors (if present, otherwise among specialty trainees) over the 12 months prior to the 2016 contract reform. Controls included but omitted from the table: an indicator variable for female trainees and three age indicator variables (younger than 30, aged 31-40, older than 40). Standard errors are clustered at the hospital level. 95% confidence intervals are reported in parenthesis. Significance levels: * 0.1; ** 0.05 *** 0.01.

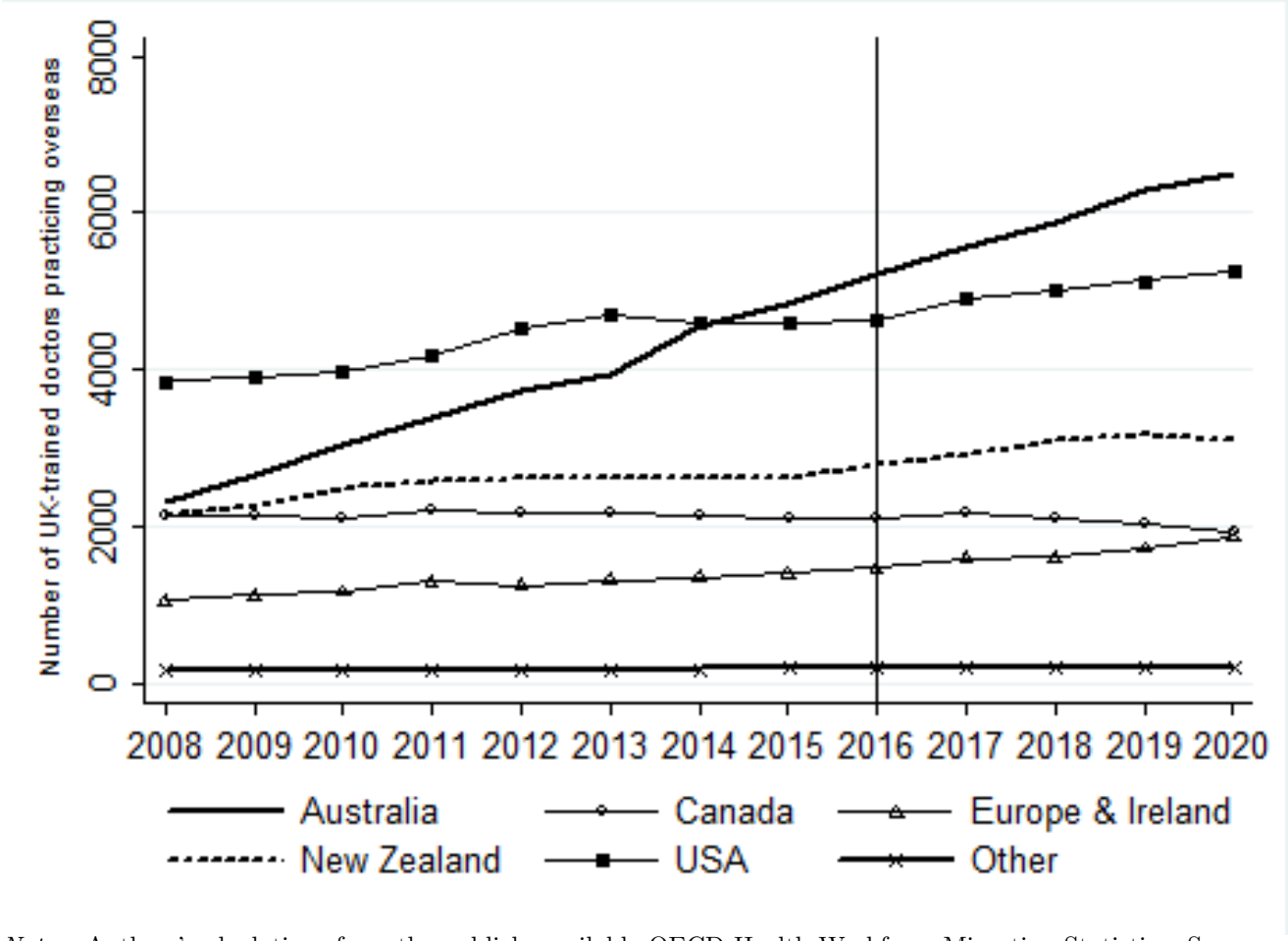
Online Appendix Figures and Tables

Figure A.1. Share of home-trained doctors practicing overseas by country



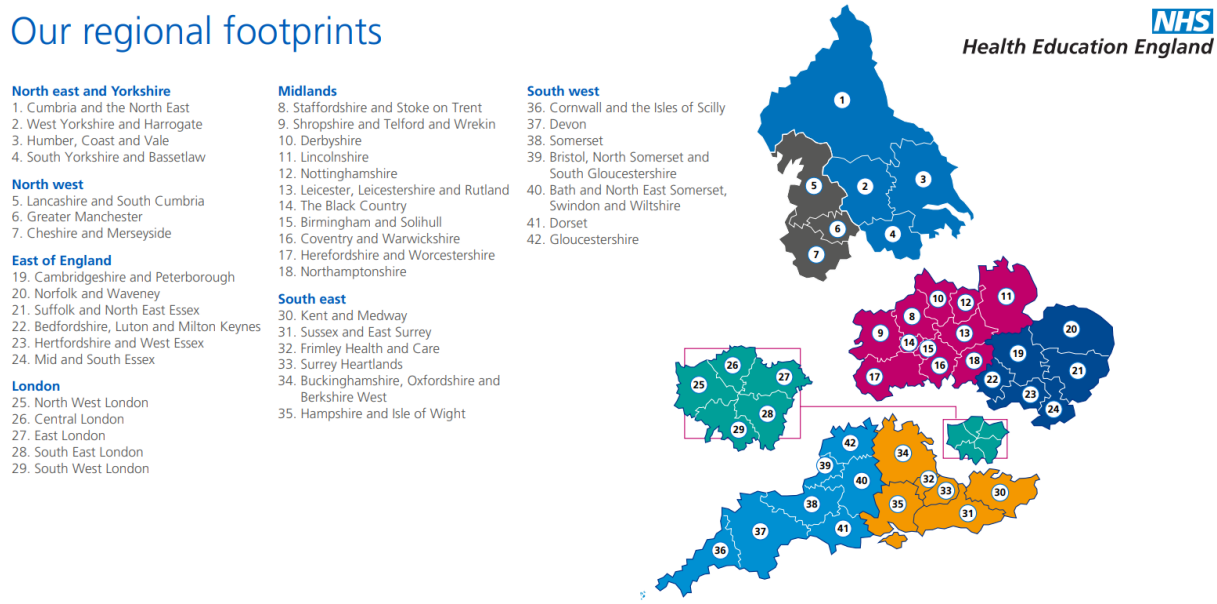
Notes. Authors' calculations from the publicly available OECD Health Workforce Migration Statistics. See Burn-Murdoch (2023) for additional insights on the topic.

Figure A.2. Number of UK-trained doctors practising overseas by destination country



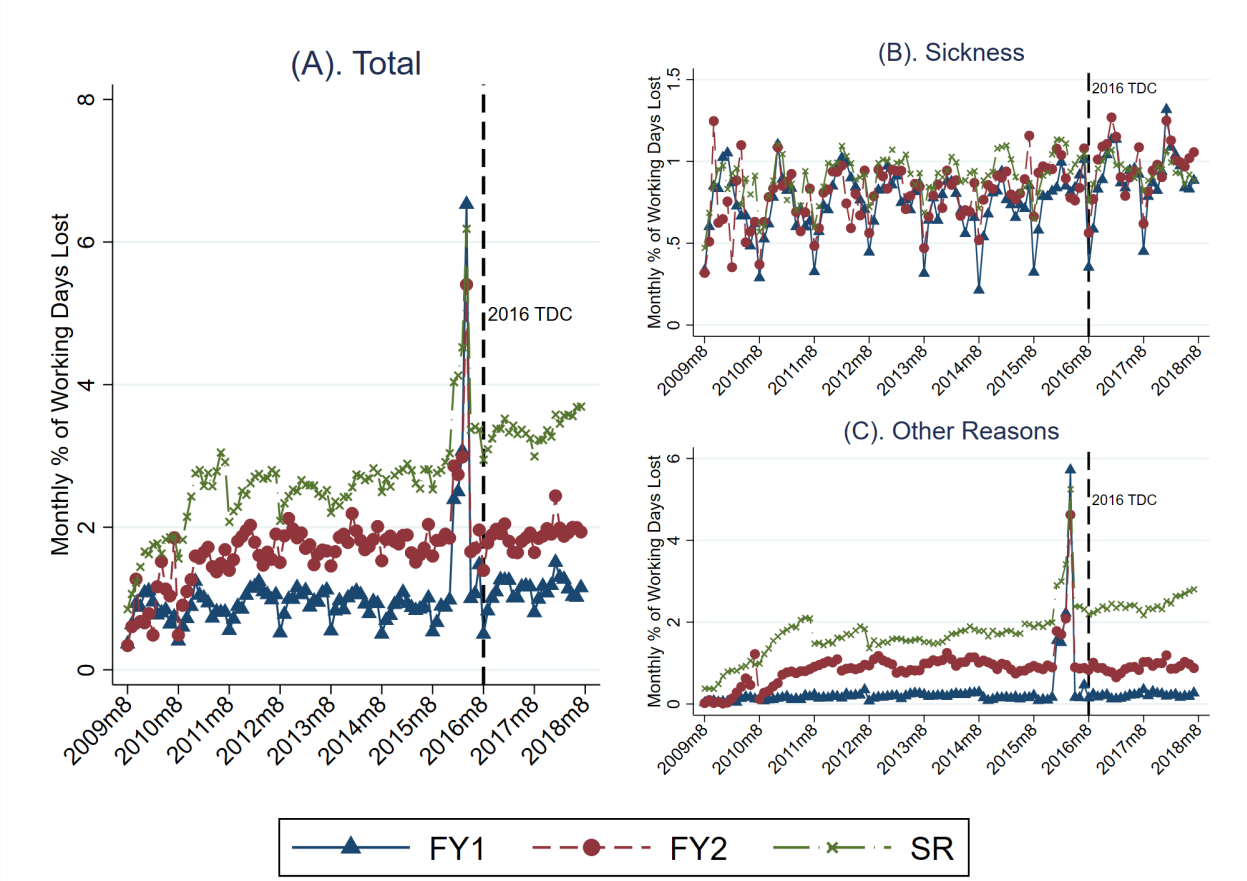
Notes. Authors' calculations from the publicly available OECD Health Workforce Migration Statistics. See Burn-Murdoch (2023) for additional insights on the topic.

Figure A.3. HEE regions and subregions



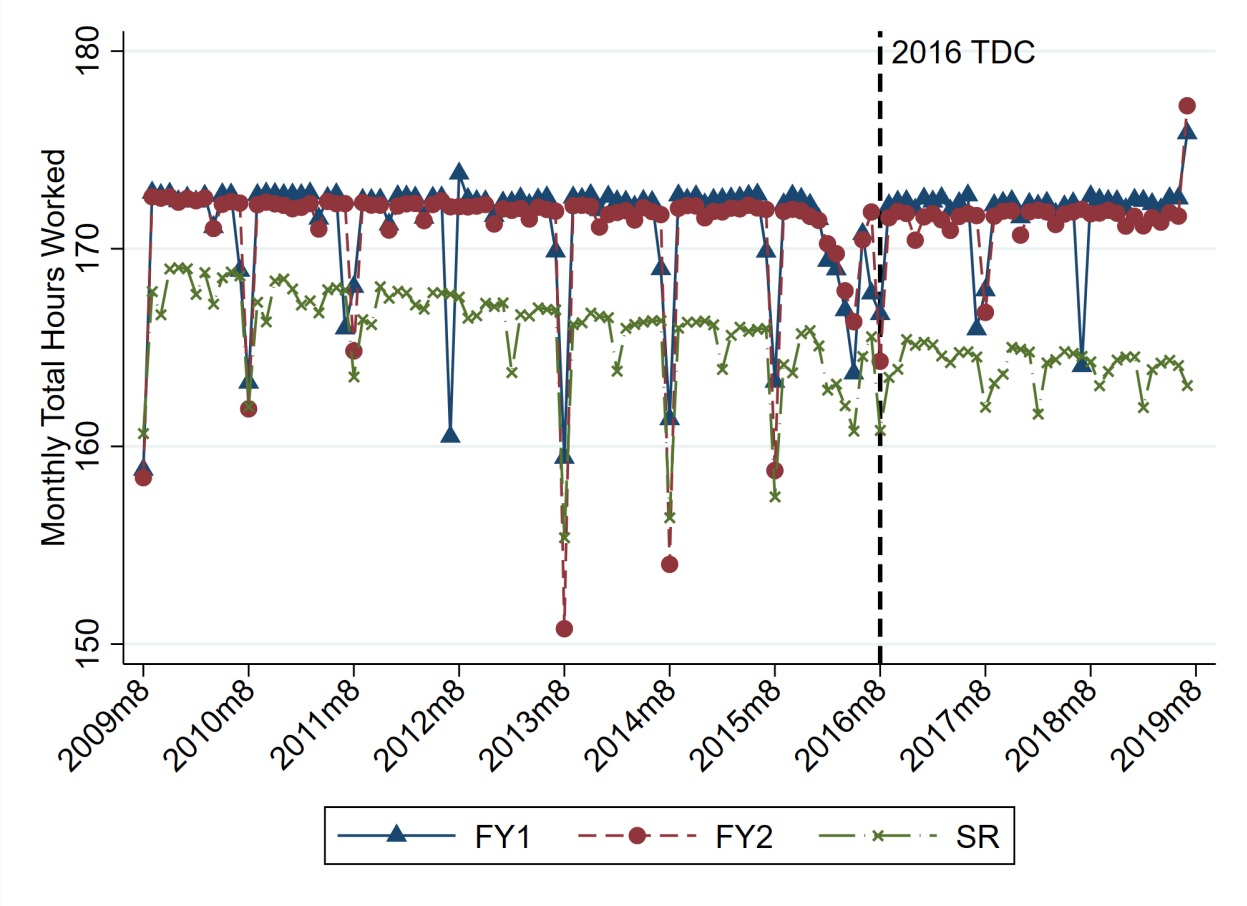
Notes. Source: Health Education England, at `https://www.hee.nhs.uk/`.

Figure A.4. Trainee doctors' monthly absence rates



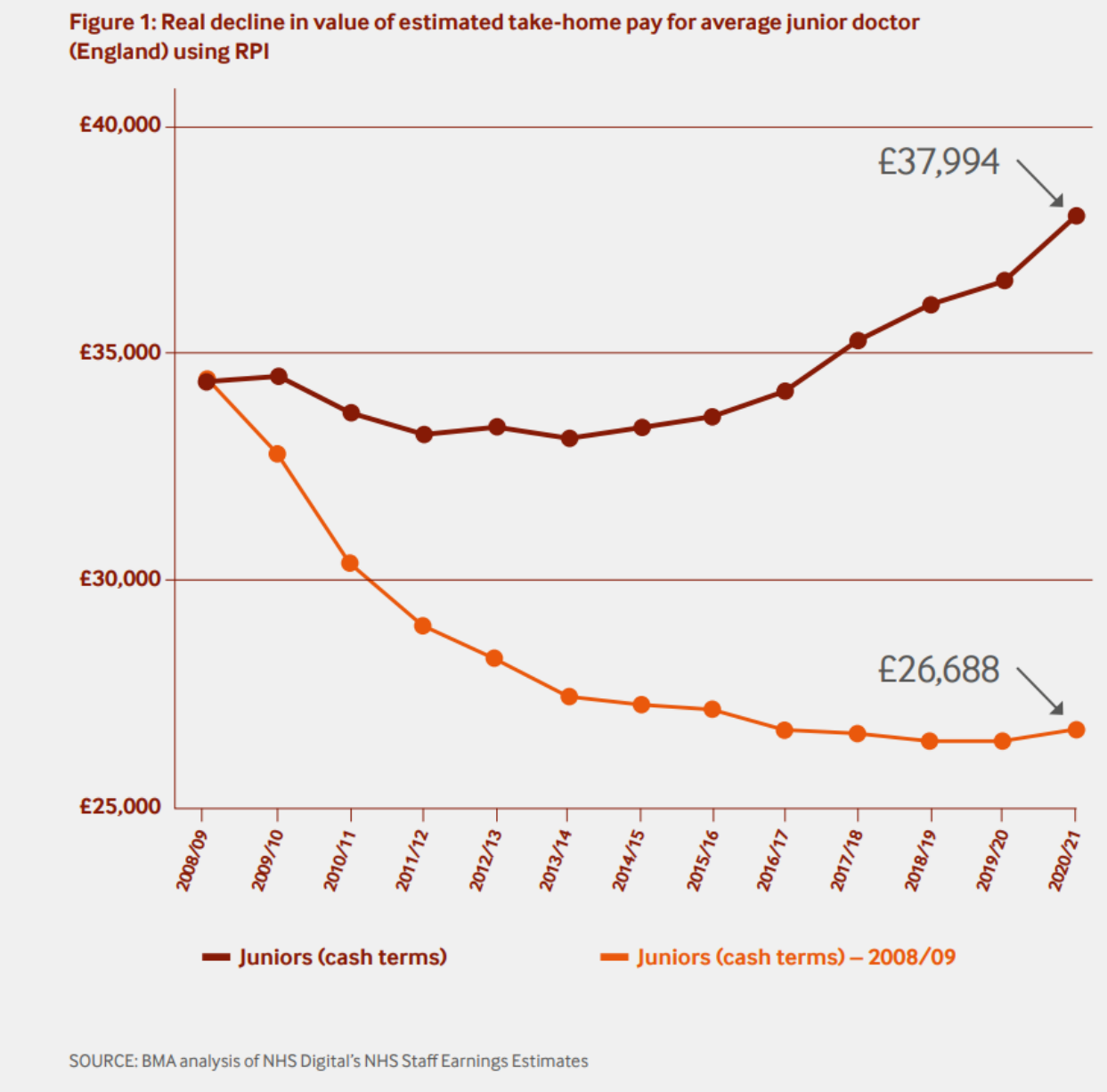
Notes. Authors' calculation from the Electronic Staff Records (ESR), using data for all NHS trainee doctors between August 2009 and July 2018. 2016 TDC = official starting implementation date of the 2016 Trainee Doctor Contract. FY1 = Foundation Year 1; FY2 = Foundation Year 2; SR = Specialty Registrar.

Figure A.5. Monthly Hours Worked



Notes. Authors' calculation from the Electronic Staff Records (ESR), using data for all NHS trainee doctors between August 2009 and July 2018. 2016 TDC = official starting implementation date of the 2016 Trainee Doctor Contract. FY1 = Foundation Year 1; FY2 = Foundation Year 2; SR = Specialty Registrar.

Figure A.6. Trainee doctors' real terms annual earnings, 2008-2021



Notes. Source: BMA computations (`https://www.bma.org.uk/media/5093/junior-doctor-pay-briefing-feb-2022-v1.pdf`).

Figure A.7. Data sources and linkages

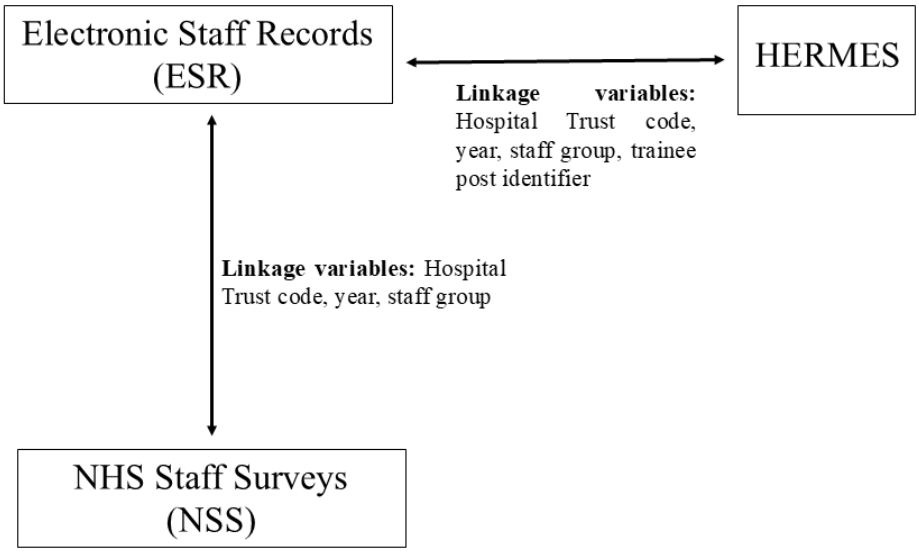
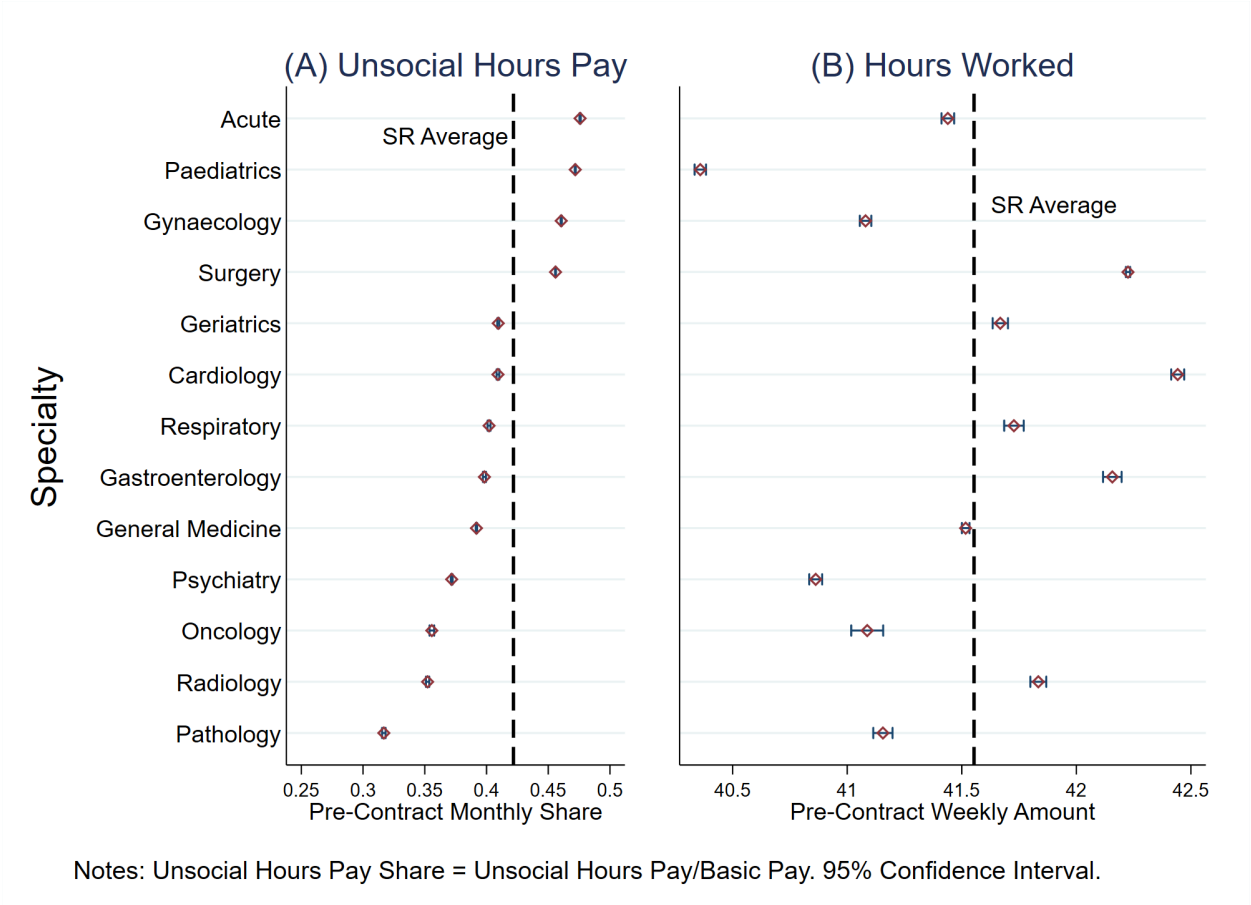
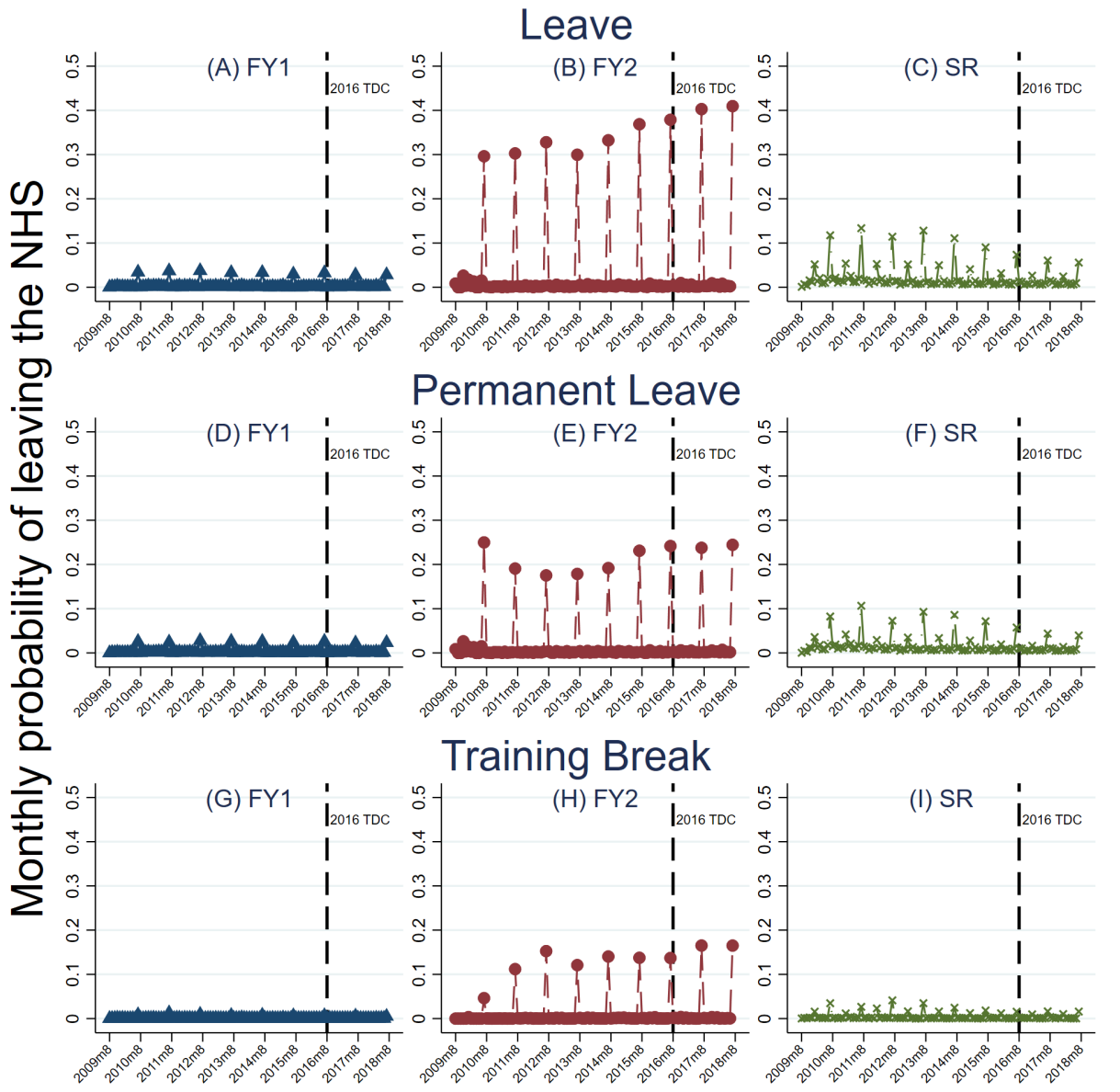


Figure A.8. Share of unsocial working hours and total hours worked, by specialty



Notes. Authors' calculation from the Electronic Staff Records (ESR), using data for NHS specialty trainee doctors between August 2009 and July 2016. SR = Specialty Registrar.

Figure A.9. Monthly Leaving Rates



Notes. Authors' calculation from the Electronic Staff Records (ESR), using data for all NHS trainee doctors between August 2009 and July 2018. 2016 TDC = official starting implementation date of the 2016 Trainee Doctor Contract. FY1 = Foundation Year 1; FY2 = Foundation Year 2; SR = Specialty Registrar.

Figure A.10. Event-study estimates for the falsification test using a sample of hospital consultants

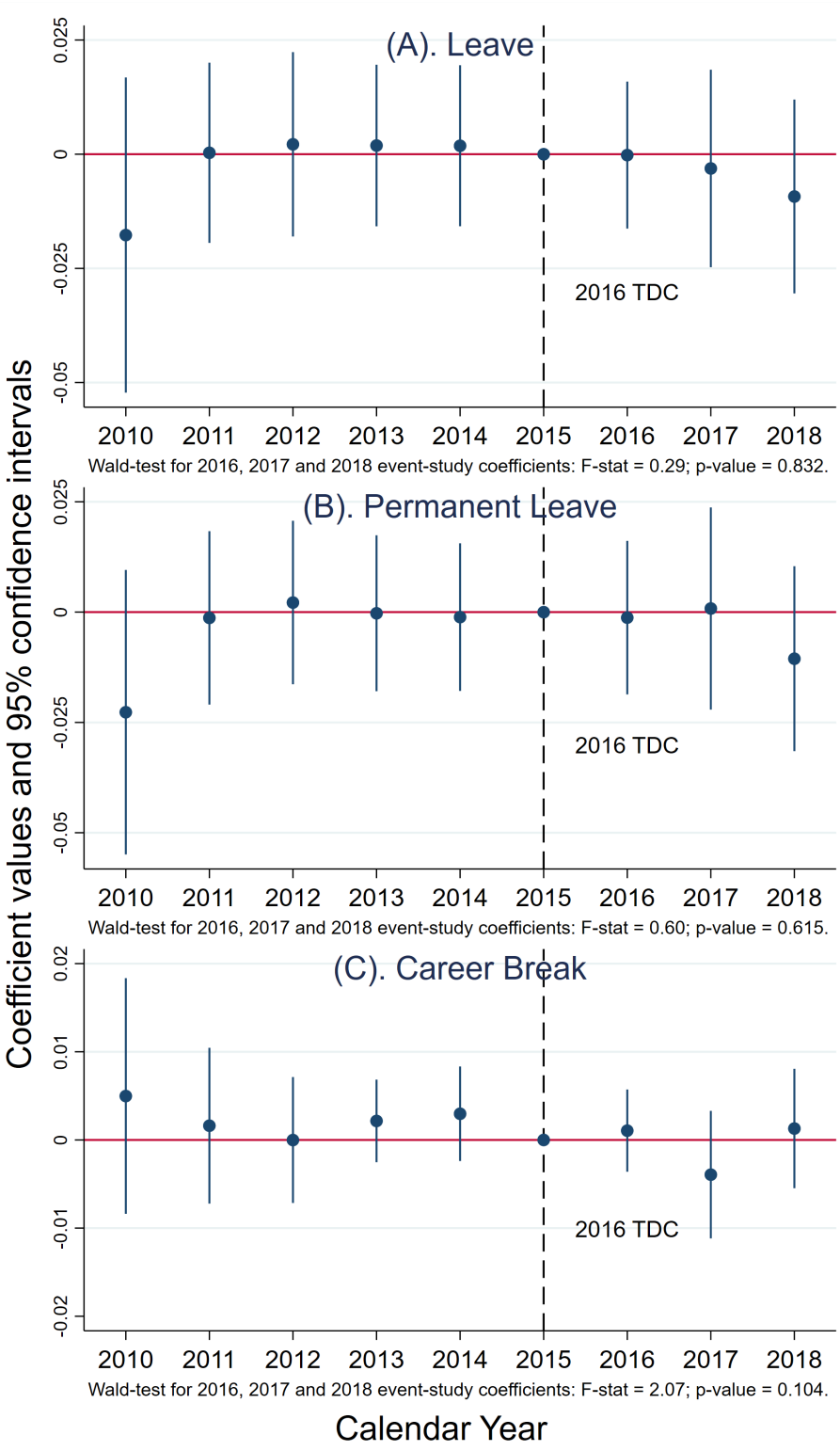


Figure A.11. Event-study estimates for the falsification test using a sample of SAS doctors

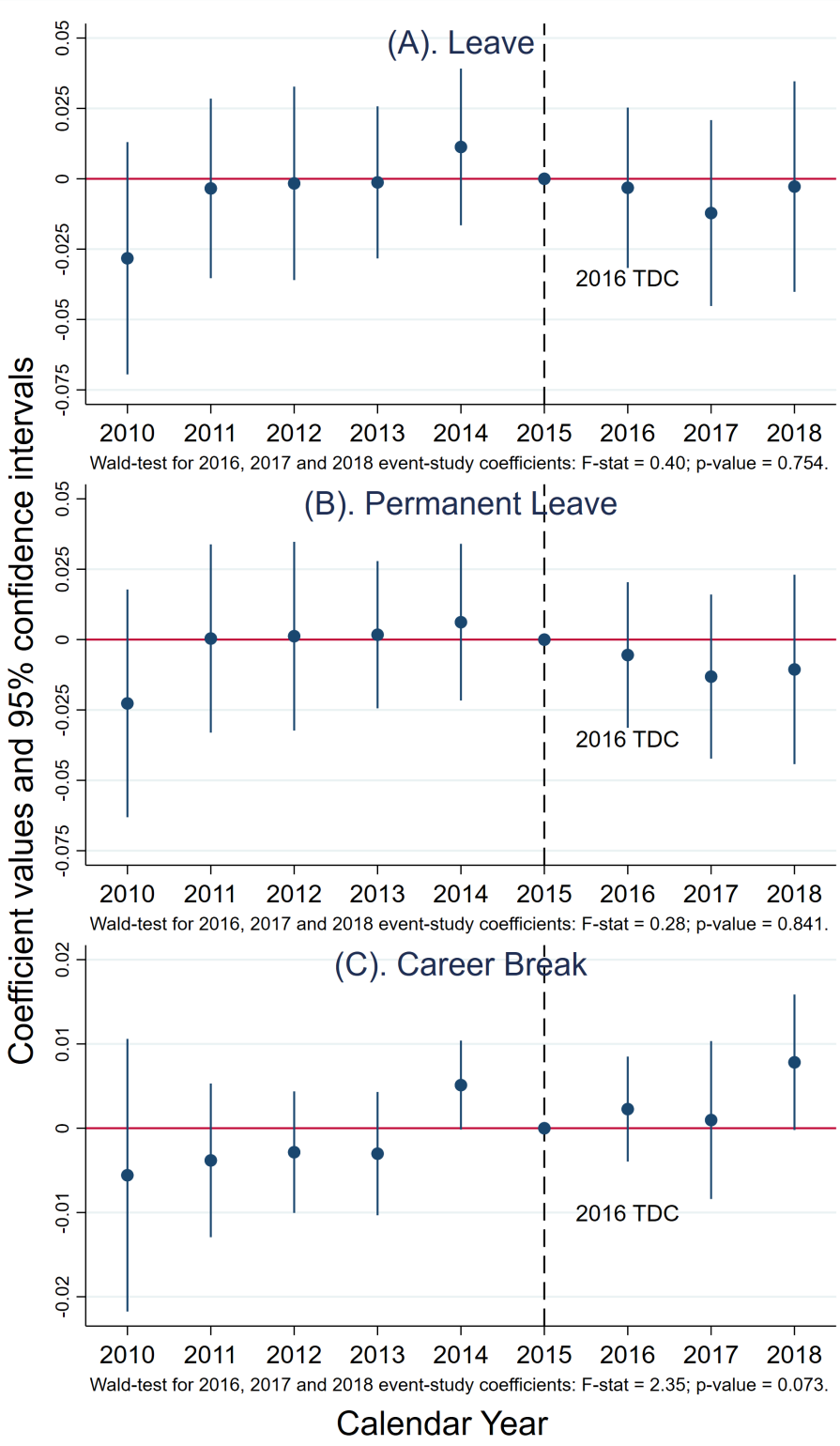


Figure A.12. Event-study estimates for the falsification test using a placebo contract date

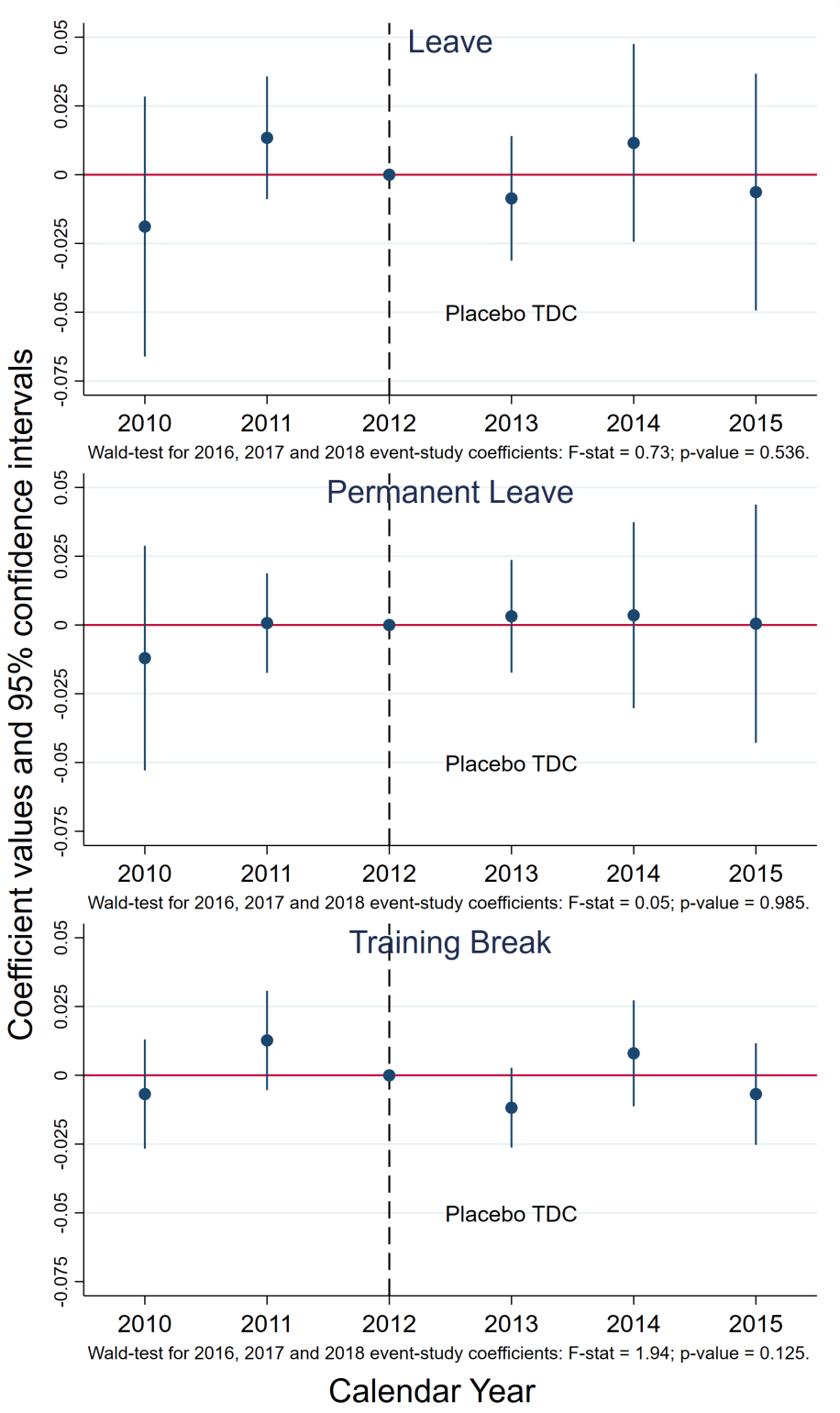


Figure A.13. Gendered effects of the 2016 contract on trainees' attrition from the NHS

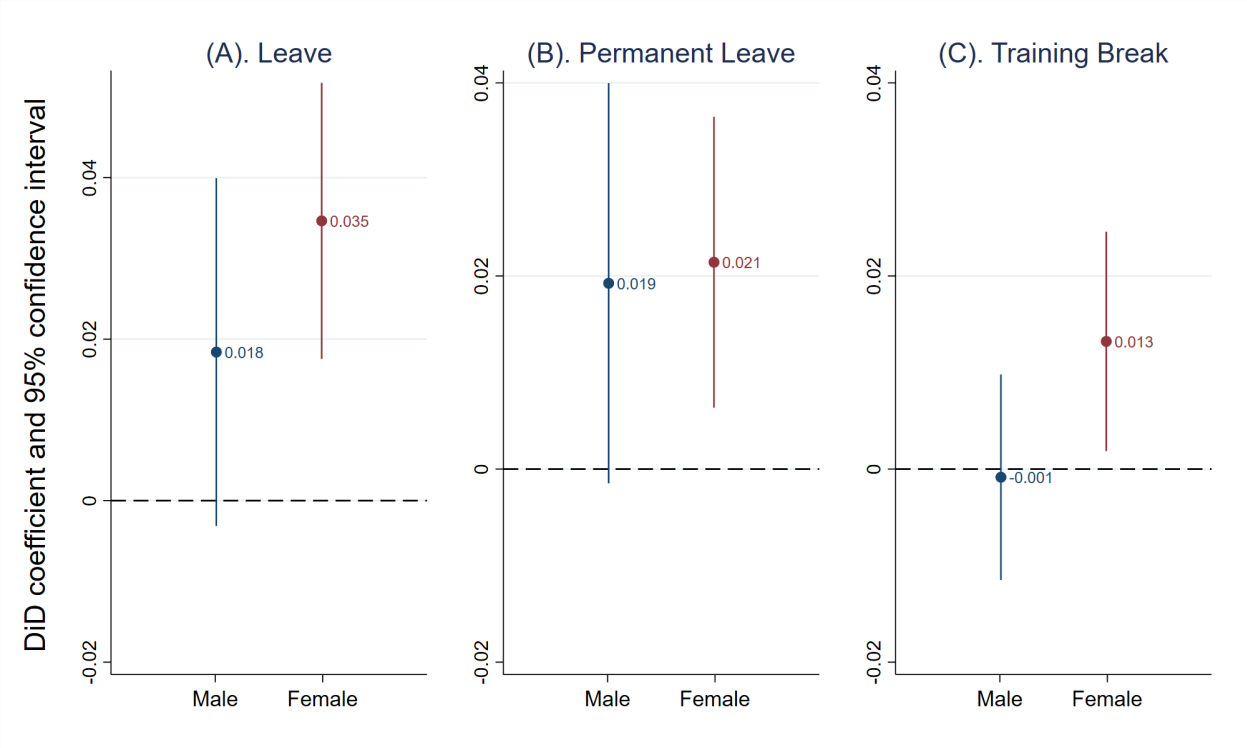


Table A.1. Summary statistics: Trainee Doctors' sample in the pre-reform period

	All	FY1	FY2	ST1-ST3	ST4-ST8
Basic Pay (in £)	2,250.29	1,858.27	2,299.58	2,574.60	2,957.63
	(389.35)	(169.65)	(166.68)	(278.48)	(301.00)
Unsocial Hours Supplement Pay (in £)	906.54	729.83	852.12	1,121.77	1,300.71
	(404.28)	(275.61)	(455.39)	(345.80)	(374.87)
Total Earnings (in £)	3,256.52	2,669.57	3,251.87	3,813.91	4,412.37
	(744.18)	(423.48)	(588.48)	(584.88)	(635.87)
Weekly Hours Worked	42.65	42.77	42.79	42.41	42.30
	(3.49)	(3.52)	(3.02)	(3.80)	(3.91)
Share of Leaving NHS (L)	0.02	0.00	0.03	0.02	0.01
	(0.13)	(0.07)	(0.17)	(0.13)	(0.12)
Share of Permanently Leaving NHS (PL)	0.01	0.00	0.02	0.01	0.01
	(0.10)	(0.06)	(0.13)	(0.11)	(0.10)
Share of Training Break (TB)	0.01	0.00	0.01	0.01	0.00
	(0.08)	(0.03)	(0.11)	(0.08)	(0.07)
Age	27.29	25.94	26.91	28.75	30.97
	(3.64)	(3.42)	(3.39)	(3.34)	(3.16)
Share of Female	0.58	0.58	0.59	0.57	0.54
	(0.49)	(0.49)	(0.49)	(0.50)	(0.50)
Share of BAME	0.29	0.29	0.29	0.28	0.27
	(0.45)	(0.45)	(0.45)	(0.45)	(0.45)
Share of British	0.85	0.83	0.85	0.86	0.86
	(0.36)	(0.38)	(0.36)	(0.35)	(0.34)
Share of European	0.05	0.05	0.05	0.05	0.05
	(0.22)	(0.22)	(0.21)	(0.22)	(0.22)
Share of Overseas (non-UK, non-EU)	0.07	0.08	0.07	0.07	0.07
	(0.26)	(0.27)	(0.26)	(0.26)	(0.26)
Trainees	40,954	40,947	32,994	16,514	4,625
Observations	1,320,263	464,692	402,792	401,315	51,464

Notes. Standard deviation in parenthesis. Leave (L) = Leave the ESR for more than 6 months. Permanent Leave (PL) = Leave the ESR for more than 13 months. Training Break (TB) = Leave the ESR for a period ranging between 7 and 13 months. BAME = Black, Asian or other ethnic minorities. FY1 = Foundation Year 1; FY1 = Foundation Year 2; SR1-SR3 = Specialty Registrar (1-3 years); SR4-SR8 = Specialty Registrar (4-8 years). All variables are expressed on a monthly basis if not specified otherwise.

Table A.2. Event-study estimates of the 2016 TDC effect on trainee doctors' attrition from the NHS

	(1)	(2)	(3)	(4)	(5)	(6)
	L	PL	TB	L	PL	TB
Year 2010 * Unsocial Work Exposure	-0.011	-0.012	0.001	-0.018	-0.018	-0.000
	(0.011)	(0.010)	(0.003)	(0.034)	(0.034)	(0.009)
Year 2011 * Unsocial Work Exposure	0.015	-0.000	0.015***	0.023	0.003	0.019*
	(0.012)	(0.011)	(0.006)	(0.024)	(0.023)	(0.010)
Year 2012 * Unsocial Work Exposure	0.009	0.006	0.003	0.016	0.010	0.006
	(0.011)	(0.009)	(0.007)	(0.021)	(0.020)	(0.010)
Year 2013 * Unsocial Work Exposure	0.010	0.010	-0.001	0.012	0.012	0.000
	(0.011)	(0.011)	(0.005)	(0.017)	(0.017)	(0.009)
Year 2014 * Unsocial Work Exposure	0.006	-0.003	0.008*	0.005	-0.003	0.009
	(0.010)	(0.009)	(0.005)	(0.012)	(0.012)	(0.008)
Year 2016 * Unsocial Work Exposure	0.012	0.007	0.005	0.019**	0.010	0.009
	(0.008)	(0.007)	(0.004)	(0.010)	(0.009)	(0.007)
Year 2017 * Unsocial Work Exposure	0.029**	0.028***	0.001	0.040***	0.035***	0.005
	(0.012)	(0.010)	(0.007)	(0.013)	(0.013)	(0.008)
Year 2018 * Unsocial Work Exposure	0.019*	0.012*	0.006	0.038***	0.025**	0.013*
	(0.010)	(0.007)	(0.006)	(0.014)	(0.012)	(0.008)
N		40,954			40,954	
N * T		1,761,537			1,761,537	
Individual FE	✗	✗	✗	✓	✓	✓
R-squared	0.187	0.107	0.082	0.216	0.140	0.108

Notes: L = Leave the ESR for more than 6 months. PL = Leave the ESR for more than 13 months. TB = Leave the ESR for a period ranging between 7 and 13 months. The sample goes from January 2010 to December 2018 and is made of only trainee doctors joining the NHS as Foundation Year 1 under the 2002 contractual terms (i.e. Cohorts 2009-2015). All models include: year fixed effects; hospital organization fixed effects; grade-specific calendar month fixed effects; grade-specific specialty fixed effects; a dummy taking value one between January and June 2016 (i.e. trainee doctors' strikes); a polynomial of degree two in trainee doctors' age. The specifications without individual fixed effects (columns 1-3) also include a series of dummy variables controlling for: the first NHS hospital organization entered by trainee doctors; gender; nationality; ethnicity; NHS cohort of entry. N denotes the number of trainee doctors used in the estimation. $N * T$ denotes the overall number of monthly trainee doctors' records used in the estimation. Standard errors clustered by the first NHS hospital organization joined by trainee doctors are reported in parenthesis. Significance levels: * 0.1; ** 0.05 *** 0.01.

Table A.3. Effect on trainee doctors' attrition from the NHS, controlling for work intensity

	(1)	(2)	(3)
	L	PL	TB
2016 Contract	0.226***	0.139**	0.087**
	(0.066)	(0.057)	(0.034)
2016 Contract * Unsocial Work Exposure	0.031***	0.022***	0.008*
	(0.008)	(0.007)	(0.005)
2016 Contract * Working Hours Exposure	-0.006***	-0.003***	-0.002**
	(0.002)	(0.001)	(0.001)
N		40,954	
N * T		1,761,537	
R-squared	0.216	0.140	0.108

Notes: L = Leave the ESR for more than 6 months. PL = Leave the ESR for more than 13 months. TB = Leave the ESR for a period ranging between 7 and 13 months. $Hours$ is defined following the approach described in subsection 4.2 to define UNS. The specifications include: individual fixed effects; hospital organization fixed effects; grade-specific calendar month fixed effects; grade-specific specialty fixed effects; a dummy taking value one between January and June 2016 (i.e. trainee doctors' strikes); a polynomial of degree two in trainee doctors' age. N denotes the number of trainee doctors used in the estimation. $N * T$ denotes the overall number of monthly trainee doctors' records used in the estimation. Standard errors clustered by the first NHS hospital organization joined by trainee doctors are reported in parenthesis. Significance levels: * 0.1; ** 0.05 *** 0.01.

Table A.4. Effect on trainee doctors' attrition from the NHS, controlling for the Brexit referendum results

	Overall			By nationality		
	(1) L	(2) PL	(3) TB	(4) L	(5) PL	(6) TB
Panel A: Augmented Brexit Referendum specification						
2016 Contract	-0.012***	-0.016***	0.004*	-0.012***	-0.016***	0.004*
	(0.004)	(0.004)	(0.002)	(0.004)	(0.004)	(0.002)
2016 Contract * Unsocial Work Exposure	0.027***	0.019**	0.008*	0.026***	0.018**	0.009*
	(0.008)	(0.008)	(0.005)	(0.008)	(0.008)	(0.005)
Brexit Referendum * Brexit Support Exposure	0.006	0.015***	-0.009***			
	(0.004)	(0.004)	(0.003)			
Brexit Referendum * British * Brexit Support Exposure				0.007	0.014***	-0.008***
				(0.004)	(0.004)	(0.003)
Brexit Referendum * European * Brexit Support Exposure				0.008*	0.020***	-0.013***
				(0.005)	(0.005)	(0.003)
Brexit Referendum * Non-European * Brexit Support Exposure				-0.004	0.012***	-0.016***
				(0.005)	(0.004)	(0.002)
Panel B: Placebo Brexit Referendum specification						
2016 Contract	0.003*	-0.001	0.005***	0.003*	-0.002	0.004***
	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)
2016 Contract * Brexit Support Exposure	-0.002	-0.000	-0.002			
	(0.003)	(0.003)	(0.002)			
2016 Contract * British * Brexit Support Exposure				-0.001	0.000	-0.001
				(0.003)	(0.003)	(0.002)
2016 Contract * European * Brexit Support Exposure				0.001	0.004	-0.003
				(0.004)	(0.003)	(0.002)
2016 Contract * Non-European * Brexit Support Exposure				-0.006*	-0.001	-0.005***
				(0.003)	(0.003)	(0.002)
N	40,732					
N * T	1,755,589					
R-squared	0.215	0.140	0.108	0.215	0.140	0.108

Notes: L = Leave the ESR for more than 6 months. PL = Leave the ESR for more than 13 months. TB = Leave the ESR for a period ranging between 7 and 13 months. The specifications include: individual fixed effects; hospital organization fixed effects; grade-specific calendar month fixed effects; grade-specific specialty fixed effects; a dummy taking value one between January and June 2016 (i.e. trainee doctors' strikes); a polynomial of degree two in trainee doctors' age. Brexit support exposure is the average support for Brexit in the June 2016 referendum across all NHS hospitals in which trainee doctors rotated up to the Brexit referendum date. N denotes the number of trainee doctors used in the estimation. $N * T$ denotes the overall number of monthly trainee doctors' records used in the estimation. Standard errors clustered by the first NHS hospital organization joined by trainee doctors are reported in parenthesis. Significance levels: * 0.1; ** 0.05 *** 0.01.

Table A.5. Heterogeneous effects by gender and type of appointment

	Male			Female		
	(1)	(2)	(3)	(4)	(5)	(6)
	L	PL	TB	L	PL	TB
Panel A: Gender						
2016 Contract	-0.005	-0.009*	0.004*	-0.013***	-0.011***	-0.002
	(0.005)	(0.005)	(0.002)	(0.004)	(0.003)	(0.002)
2016 Contract * Unsocial Work Exposure	0.018*	0.019*	-0.001	0.035***	0.021***	0.013**
	(0.011)	(0.010)	(0.005)	(0.009)	(0.008)	(0.006)
N		17,049			23,905	
N * T		749,078			1,012,459	
R-squared	0.229	0.153	0.109	0.207	0.132	0.108
Panel B: Gender and Type of Appointment						
2016 Contract (Full-Time)	-0.005	-0.009*	0.004*	-0.014***	-0.011***	-0.002
	(0.005)	(0.005)	(0.002)	(0.004)	(0.003)	(0.002)
2016 Contract * Part-Time	0.124	0.177	-0.053	0.010	0.000	0.010
	(0.177)	(0.155)	(0.081)	(0.031)	(0.029)	(0.019)
2016 Contract * Unsocial Work Exposure	0.019*	0.020*	-0.001	0.035***	0.021***	0.013**
	(0.011)	(0.010)	(0.005)	(0.009)	(0.008)	(0.006)
2016 Contract * Unsocial Work Exposure * Part-Time	-0.285	-0.433	0.148	-0.013	0.013	-0.025
	(0.442)	(0.376)	(0.208)	(0.073)	(0.067)	(0.045)
N		17,045			23,881	
N * T		748,888			1,011,288	
R-squared	0.230	0.153	0.109	0.207	0.132	0.108

Notes: L = Leave the ESR for more than 6 months. PL = Leave the ESR for more than 13 months. TB = Leave the ESR for a period ranging between 7 and 13 months. Part-time trainee doctors are identifies based on the mode in the trainee doctors' type of appointment during the pre-contract period. The specifications include: individual fixed effects; hospital organization fixed effects; grade-specific calendar month fixed effects; grade-specific specialty fixed effects; a dummy taking value one between January and June 2016 (i.e. trainee doctors' strikes); a polynomial of degree two in trainee doctors' age. N denotes the number of trainee doctors used in the estimation. $N * T$ denotes the overall number of monthly trainee doctors' records used in the estimation. Standard errors clustered by the first NHS hospital organization joined by trainee doctors are reported in parenthesis. Significance levels: * 0.1; ** 0.05 *** 0.01.

Table A.6. Test for parallel pre-trends

	(1)	(2)	(3)
	L	PL	TB
Panel A			
Monthly Trend	-0.000	0.000	-0.000***
	(0.000)	(0.000)	(0.000)
Monthly Trend * Unsocial Work Exposure	0.001	0.001	-0.000
	(0.001)	(0.001)	(0.000)
Panel B			
Yearly Trend	-0.001	0.002	-0.003***
	(0.003)	(0.003)	(0.001)
Yearly Trend * Unsocial Work Exposure	0.005	0.006	-0.001
	(0.007)	(0.007)	(0.002)
N		40,954	
N * T		1,320,263	
R-squared	0.229	0.150	0.114
Individual FE	✓	✓	✓
Trust FE	✓	✓	✓
Month FE	✓	✓	✓
Specialty FE	✓	✓	✓

Notes: L = Leave the ESR for more than 6 months. PL = Leave the ESR for more than 13 months. TB = Leave the ESR for a period ranging between 7 and 13 months. The specifications include: individual fixed effects; hospital organization fixed effects; grade-specific calendar month fixed effects; grade-specific specialty fixed effects; a dummy taking value one between January and June 2016 (i.e. trainee doctors' strikes); a polynomial of degree two in trainee doctors' age. The sample goes from January 2010 to July 2016 (i.e. pre-contract period) and is made of only trainee doctors joining the NHS as Foundation Year 1 under the 2002 terms (i.e. Cohorts 2009-2015). N denotes the number of trainee doctors used in the estimation. $N * T$ denotes the overall number of monthly trainee doctors' records used in the estimation. Standard errors clustered by the first NHS hospital organization joined by trainee doctors are reported in parenthesis. Significance levels: * 0.1; ** 0.05 *** 0.01.

Table A.7. Persistence of training working patterns

	(1)	(2)	(3)	(4)
	Unsocial Work Pay (SR)	Hours Worked (SR)	Unsocial Work Pay (SR)	Hours Worked (SR)
Unsocial Work Pay (FY)	0.127***		0.088***	
	(0.020)		(0.016)	
Hours Worked (FY)		0.532***		0.530***
		(0.079)		(0.080)
N	16,308		16,301	
R-squared	0.029	0.355	0.130	0.207
Current Trust FE	✗	✗	✓	✓
Specialty FE	✗	✗	✓	✓

Notes: OLS estimates of a cross-sectional model relating the average value of unsocial work supplement earnings as percentage of basic salary (columns 1 and 3) and hours worked (columns 2 and 4) in the first 12 months of Specialty training with the corresponding averages during the Foundation Programme. Only trainee doctors who underwent (at least part of) both the Foundation and the Specialty training before August 2016 are used for the analysis. Specialty dummies (included in columns 3 and 4 only) refer to the medical area of work recorded by trainee doctors at the beginning of their Specialty training. All models also control for demographic (gender, age, ethnicity, nationality), NHS cohort, medical training (i.e. first hospital organization entered by trainee doctors) and year dummies. *N* denotes the number of trainee doctors (observations) used in the estimation. Standard errors clustered by the first NHS hospital organization entered by trainee doctors are reported in parenthesis. Significance levels: * 0.1; ** 0.05 *** 0.01.

Proof of Remark 1

Consider two doctors, h and l, with the same level of consumption utility pre-reform: (i) $u(s_0^h) + u(e_0^h) = u(s_0^l) + u(e_0^l) = \bar{u}$. Suppose doctor h has higher exposure to unsocial hours than doctor l, so, (ii) $\frac{e_0^h}{s_0^h} > \frac{e_0^l}{s_0^l}$. Given both (i) and (ii) and that utility is strictly increasing, we must have $e_0^h > e_0^l$ and $s_0^h < s_0^l$.

We will now characterise all functions under which our claim is true. Specifically, we want to characterise all utility functions under which $\Delta u(s^h) < \Delta u(s^l)$ and $\Delta u(e^h) < \Delta u(e^l)$. We solve for the case of s and the case of e follows from the same argument. Let $s_1^i = \alpha s_0^i$ and $e_1^i = \beta e_0^i$ where $\alpha > 1$ and $0 < \beta < 1$. $\Delta u(s^h) < \Delta u(s^l)$ if and only if $u(\alpha s_0^h) - u(s_0^h) < u(\alpha s_0^l) - u(s_0^l)$. This is true if $f(s) = u(\alpha s) - u(s)$ is increasing in s; hence, $f'(s) = \alpha u'(\alpha s) - u'(s) > 0$ for $\alpha > 1$. Note that this is true if $\alpha u'(\alpha s)$ is increasing in α; i.e., if $u'(\alpha s) + s u''(\alpha s) > 0$. Hence, for all utility functions that satisfy $u'(\alpha s) + s u''(\alpha s) > 0$ (including any utility function linear in money as well as CRRA utility functions), our claim holds.