The Role of Top Managers in the Public Sector: Evidence from the English NHS

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Abstract

Governments have reformed public services by adopting private sector governance models that grant top directors greater autonomy, responsibility for meeting key targets, and performance-based rewards. We examine a central plank of this approach–that directors can impact the organizations they run–in the context of English public hospitals, complex organizations with multi-million turnover. Our findings reveal little evidence that top directors affect hospital production, although pay differentials suggest they are perceived as distinct by the market. The results question the effectiveness of blindly mimicking the private sector to bring about improvements in public sector performance. (JEL H51, I11, L32, M12)

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1 Introduction

From the 1980s onward, governments worldwide sought to reform the delivery of public services by moving away from traditional centralised bureaucracies. Key features of these reforms were changes towards more specialized and autonomous organizations, coordinated by means of market mechanisms and contractual relationships with the government rather than hierarchies of bureaucratic authority. These reforms put much more emphasis on the role of senior managers, giving them greater autonomy to run their organizations while holding them accountable through manager-specific compensation policies, performance-related pay, and tighter monitoring and dismissal for failure to meet explicit performance targets (Besley & Ghatak 2003, Le Grand 2003, Dixit 2002).

In this paper, we provide new evidence on the impact of senior managers in a context that epitomizes the attempt to shift public sector organizations from traditional bureaucracies to more accountable and autonomous entities: the English National Health Service (NHS). NHS hospitals are large organisations, with an average of 4,500 employees, that treat over 75,000 patients per year and have multi-million pounds turnover. From the late 1980s onward, the UK government embarked on a large reform program that replaced a traditional administrative approach with a highly decentralized managerial model, in which senior directors, chosen and rewarded by local hospital boards in an autonomous fashion, were accountable for the performance of individual public hospitals. While hospitals remained under public ownership, central budgets were replaced by local contracts for service delivery, which were won in competition with other NHS hospitals. Directors were held accountable through frequent and visible monitoring of clinical and financial targets set by the central government, against which the performance of the CEO and other directors was regularly assessed. Failure to meet these targets could lead to public 'naming and shaming' and dismissal of the directors.

Critical for our study, these institutional changes were accompanied by frequent movements of top directors across different but comparable NHS hospitals, providing an ideal setting to evaluate whether differences in hospital performance could be attributed to members of the senior management team, in isolation from other persistent differences in hospital characteristics and other time-varying factors.

We are able to measure hospital performance for a long time period (2000-2014) using a large set of hospital production measures, focusing on those that have been used as published targets by politicians for NHS hospitals at various points during (and for some measures before) the 14-year period we examine. These measures include financial surplus (the equivalent of profit in the NHS context) and important clinical and non-clinical aspects of hospital production. We also examine staff satisfaction, regarded within the NHS as an organisational characteristic arising from a top-down managerial effort to keep workers motivated in their jobs, and shown to be associated with clinical quality of care and recruitment and retention (e.g. Badgett et al. (2020), Shields & Ward (2001)).

This setting also allows us to examine a central plank of the reform, i.e. that local boards would use their autonomy to set directors' pay granted to them by the Government to reward managerial performance. Since the NHS requires hospitals to publish the pay awarded to their top managers (including bonuses), we can examine the extent to which pay systematically varies across individual top managers, and whether higher managerial pay is associated with significant individual contributions to hospital performance.

Our analysis is based on the two-way fixed effects model pioneered by Abowd et al. (1999) and exploits the (considerable) movement of top managers across a fairly stable set of hospitals, which allows us to decompose variations in hospital performance and director pay into hospital and director effects. The nature of the labor market means that we have one large connected set, so we can directly compare director and hospital effects across all directors and all hospitals. Our estimates can be interpreted causally even if top managers sort across hospitals based on the effectiveness of manager or the hospital. Instead, the assumptions needed for causal interpretation are that they do not sort based on unmodelled match effects, and that drift in hospital effectiveness and switches are uncorrelated. We provide event study evidence to support these assumptions. In addition, we correct for the well-known problem of limited mobility bias (Andrews et al. 2008) by using the leave-one-out estimator proposed by Kline et al. (2020) to estimate the covariance between hospital and director effects. We complement this decomposition analysis with an analysis of director-hospital spells and event studies.

We find little evidence of managerial impact on hospital performance: senior managers' fixed effects in hospital performance have much lower explanatory power relative to hospital fixed effects, while the latter generally account for a large fraction of the variance in performance. The reason for such low explanatory power comes down to two facts. First, on average, permanent manager effects explain relatively little of the variance in performance once hospital fixed effects are included. Second, the small residual spell-specific variation that can be attributed to individual managers within a specific hospital is uncorrelated across spells in different hospitals by the same manager. That is, contrary to the findings of Bertrand & Schoar (2003), who examined the importance of top managers in the context of large and complex US organizations in the private sector, managerial effects are not portable across hospitals. These findings are very similar for both CEOs and the other top directors.

We explore whether the lack of detectable managerial effects on performance is related to the short average tenure or directors (3.7 years on average), since this may inhibit the ability to leave a mark on complex organizations. This explanation is supported by the finding that directors who have a positive spell effect in a hospital have had longer tenure at that hospital. However, absent exogenous variation in assignment of directors to hospitals, we cannot rule out the possibility that long tenure is an endogenous response to good hospital performance.

We find, however, no support for an alternative hypothesis, i.e. that the lack of managerial impact is driven by negative assortative matching of directors to hospitals. Specifically, directors who perform well in one hospital may subsequently be hired in a context where it is difficult for them to make a difference. For example, "high performers" in one hospital may be systematically sought after by boards in under-performing hospitals. Such negative assortative matching could limit the portability of managerial performance across hospitals, since the best directors would be systematically hired by poor performers or to harder-to-change organizations. We find little evidence in support of this explanation. Boards of more challenging hospitals do not appear to hire directors who have previously performed better than the average in a previous hospital. This is true when we measure under-performance using specific measures of production, or when we apply external indicators for under-performance. If anything, better performing directors in one hospital are more likely to be subsequently hired by hospitals which are more prestigious or are performing better in terms of key outputs–that is, we find evidence of *positive* assortative matching.

In contrast with the lack of differentiation in performance, we find evidence of significant differentiation in pay across directors. Pay effects account for nearly three times more of the variance in pay across hospitals than the permanent component of pay attributed to hospitals, and individual directors' pay is highly correlated across spells in different hospitals, i.e. it is portable. These pay differences, however, are typically not or negatively correlated with performance, either in the long run (i.e. throughout the directors' careers) or within hospital spells. Boards do appear to use pay to fill vacant directorial roles: using an event study design, we show that directors receive a pay increase when they move. However, once again changes in pay around a move are uncorrelated with observable changes in hospital performance. Overall, these findings suggest that, contrary to one of the key premises of the reforms, boards did not pay managers for performance nor they were able to use pay to attract high-performers to their organizations.

In sum, we document that the attempt to improve hospital performance through the actions of a cadre of empowered and accountable top directors and equally autonomous local boards–absent other interventions aimed at improving the recruitment and selection of these individuals–was not successful on two levels. First, directors appear to have had a relatively small impact on hospital performance within the NHS. Second, local boards do not appear to have been able to use pay as a way to select and retain capable directors.

Our results stand in stark contrast with recent findings showing evidence of managerial differentiation for smaller public sector organizations, for example, Fenizia (2022), Munoz & Prem (2022) and Best et al. (2023).[1] Our findings also contrast with the positive effects of CEOs for hospital performance documented for Chile by Otero & Munoz (2022).[2] Differently from our setting, the Chilean reform focused explicitly on increasing the entry of CEOs with formal managerial training in hospitals, whereas the NHS reforms were predicated on the idea that greater performance could be achieved by providing more autonomy and incentives to existing hospital managers, regardless of their formal managerial education.

Other structural factors may account for the lack of a director effect, including the fact that NHS directors (and especially CEOs), whilst well paid relative to other public sector employees, may not have been paid enough relative to the private sector to attract capable directors from outside the NHS. As a consequence, the emphasis on senior management may have increased the frequency of managerial rotations across hospitals without fundamentally increasing the underlying talent pool. The lack of a permanent effect of senior directors may also be due, more broadly, to the complexity of large NHS hospitals, which transcends the specific constraints imposed by public ownership.

Our study builds on the extensive literature that has examined the role of top managers in the private sector by exploiting movement across organisations to isolate the impact of individual top managers (studies include Bertrand & Schoar (2003), Bennedsen et al. (2006), Bamber et al. (2010), Dejong & Ling (2013), Graham et al. (2013) and Baltrunaite et al. (2023)). It specifically adds to prior research on the impact of managers in the public sector. To date, the role of managers in the public sector has been investigated for either relatively small organizations or ones in which the level of task complexity is low. In several such settings, managers have been found to have an effect on performance

[1]Fenizia (2022) finds managers affect the productivity of workers in a government agency administering social security benefits in Italy. Best et al. (2023) studies procurement in the Russian state and find that nearly 40 percent of the variation in prices paid for narrowly defined items is due to the individual bureaucrats and organizations who manage procurement.

[2]Otero & Munoz (2022) study the role of hospital CEOs in the public sector in Chile, where a reform in the selection of top managers led to the entry of a younger pool of managerially trained CEOs. Using a difference-in-differences design, they find that these managers (who typically replaced physicians as senior managers) improved performance and ascribe their findings to the newer managers having more managerial training and skill.

of public organisations. Several papers investigate the impact of principals on student performance (Munoz & Prem 2022, Böhlmark et al. 2016, Grissom et al. 2015, Branch et al. 2012, Coelli & Green 2012). Lavy & Boiko (2017) find that superintendents affect student performance. In contrast to the organizations examined in these papers, the hospitals we study are large and complex, with multiple objectives arising from their position as deliverers of key services funded from the public purse.

Our study also relates to the literature that examines management practices in public sector settings. There is evidence that better managerial practices improve performance: Bloom, Propper, Seiler & Reenen (2015) find better managerial practices are associated with higher financial and clinical performance in the English NHS. Bloom, Lemos, Sadun & Van Reenen (2015) find managerial practices adopted by school principals are correlated with school performance and Rasul & Rogger (2018) find that management practices in the Nigerian Civil Service affect the behaviour of government bureaucrats. We do not directly examine managerial practices, but in the same spirit as other papers that exploit mobility of workers, we exploit job movement of top managers across hospitals to extract long term managerial differences uncontaminated by hospital effects. This approach allows us to contrast the extent of variation in production driven by managers with that driven by the hospitals.

In contrast to all previous research on the public sector, we study not just the top manager of an organisation, but all members of the top managerial team. This focus on the top team allows us to exploit the considerable movement of directors across hospitals, giving us observations on around 2000 senior managers. These managers are linked into one single large connected set allowing us to decompose variation in Board effects into hospital and managerial effects across for almost all acute short term hospitals in the English NHS. This large connected set is in contrast the smaller ones used in earlier studies of public organisations, including schools, and agencies of the local and national state (e.g. Fenizia (2022)) and means we can directly compare director and hospital effects across all managers and all hospitals. The focus on the top team also means we are able to shed light on the extent to which the CEO has different impact than the rest of their top team: something which has not been studied to date in either the public sector, or in private large firms.

Finally, in contrast to most studies of public sector managers and bureaucrats, we are able to study the link between pay and performance (Otero & Munoz (2022) is a recent exception). This allows us to delve into what top directors are paid for and to shed some light on the market for top directors, and boards' ability to pay for performance, in the English NHS.

The paper is organized as follows. Section 2 describes the components of the NPM and the evolution of the market for Board level positions in the NHS. Section 3 describes the data, including the development of executive director pay relative to the pay of other NHS staff. Section 4 provides details on our econometric approach. Section 5 presents the results and examines possible reasons for the lack of persistent director effects. Section 6 studies whether boards paid directors for performance. Section 7 concludes.

2 Managerial Reform in the English NHS

The reform model implemented in the English NHS involved giving hospitals autonomy and relying on market mechanism, while the central government would set targets against which hospital top managers were to be assessed. We outline key institutional features introduced by the reforms below.

Hospital Autonomy and Market Mechanisms From the early 1990s, English public hospitals started operating as free-standing organizations known as NHS Hospital Trusts, earning their revenue from contracts won in competition with other public hospitals. From the early 2000s, the government sought to further stimulate competition by placing contracts with a small number of private hospitals, known as Independent Sector Treatment Centres (ISTCs), that provided a selected set of planned operations and diagnostic tests. This policy was later expanded to include any private provider for elective treatments. The overall policy goal was for English NHS hospitals to operate subject to market forces rather than central guidance. Within this general policy framework, which applied to *all* hospitals, if a hospital achieved certain targets (relating primarily to financial performance and access) they were formally given a higher level of autonomy, known as Foundation Trust (FT) status. The aim was that all Trusts would get FT status by 2008, though in practice this was not achieved.[3]

Corporate Governance Structures The changes to hospital autonomy were supported by significant reforms to the management of hospitals, which gradually replaced a bureaucratic consensus management system with a general manager who had overall responsibility for service performance and management (Baggott 1994). During the wave of mid-1990s market reforms, hospitals were subject to corporate governance standards similar to the ones brought into private sector firms in the UK in 1992 (Cadbury 1992).

[3]By the end of our sample period, 62% of hospitals in our sample had FT status. We control for FT status in all regressions in the paper.

The role of hospital boards was also strengthened, and they became responsible for managing the day-to-day operation of a hospital. Trust boards had to include the Chief Executive, a Finance Director, a Nursing Director and a Medical Director, but could have more positions.[4] These executive positions were matched by their non-executive director counterparts, who were hired with the expectation that they would need to dedicate at least three days a month to the hospital. In contrast to hospital board members in the USA, these non-executive directors were remunerated. They generally met monthly (Jha & Epstein 2013) and were hands-on in terms of monitoring of the financial performance and the quality of care provided by the hospital.[5]

Top director responsibilities In addition to managing day-to-day hospital operations, Chief Executives and their boards were responsible for delivering government policy, which was embodied both in targets and in guidance. Performance against targets was subject to close scrutiny by central government. During most of the period we study, targets were predominantly focused on financial performance and reducing waiting times.[6] From 2001 onwards, the central government regulator published hospital ratings, which were based on detailed quantitative data on both financial and process metrics. From 2011 the targets started including clinical quality metrics.[7] Missing key performance targets could place a CEO and/or a top director under threat of dismissal. For example, Ballantine et al. (2008) document a strong association between a limited number of hospital performance measures and CEO turnover between 1998 and 2005. In sum, NHS CEOs and top directors became responsible for both meeting government targets and day-to-day operations of large and complex organizations operating in a potentially competitive market.

Director Selection Boards had guidance from the central government regulator on making senior appointments. CEOs and other top directors were hired in a manner similar to those of private sector firms. The Chair of the Board and the appointment com-

[4]Good practice for NHS boards is set out in `https://www.leadershipacademy.nhs.uk/wp-content/uploads/2013/06/NHSLeadership-HealthyNHSBoard-2013.pdf`. A statutory instrument (`http://www.legislation.gov.uk`) sets out the board voting members.

[5]Jha & Epstein (2013) found that approximately 40% of Boards had received formal training in quality management and that they frequently reviewed and monitored quality of care issues. 98% of Boards reported that quality of care was on the agenda at every board meeting, 77% reported to actively use patient safety data to provide staff feedback.

[6]For example, achieving FT status was conditional on meeting these targets. Propper et al. (2010) provide details on waiting times targets and their impact on performance.

[7]The focus on clinical quality was the result of an extensive investigation into systemic failure at a single hospital, Mid-Staffordshire. The final recommendations were published in 2013 in `https://www.gov.uk/government/publications/report-of-the-mid-staffordshire-nhs-foundation-trust-public-inquiry`.

mittee would generally use private sector headhunters for the selection and hiring of the CEO, and they would also either consult with, or include in the decision making process, a representative from the national government organization responsible for overseeing the NHS.[8] Top managers had career paths that involved movement between different parts of the NHS. They were predominantly individuals who had entered the NHS relatively early in their career (either as managers or as clinicians), and who were typically promoted by moving between organizations in the NHS. Thus, a typical director would have considerable experience of working across a number of NHS organizations. However, individuals who had private sector experience (either as private consultants in the health sector or in running private sector organizations) were also sometimes appointed to these positions. There was also movement of CEOs and other directors to the private sector and to posts within the wider public healthcare sector.

Director Remuneration Top director remuneration was set by the Board. From 2003, hospitals that had achieved FT status were free to set CEO and other executive and non-executive director pay, decided upon by the remuneration committee as in any private company.[9] The remuneration committee could also decide whether to link CEO and other director remuneration to corporate and individual performance. Performance, particularly against government targets, could affect pay, job tenure and future rewards. Poorly performing CEOs could be dismissed and well performing CEOs rewarded by appointment to a more prestigious NHS (or private sector) organization. In addition, good performance could also be recognized by the award of a national public honour granted by the Head of State. In contrast, the pay of clinical staff (including physicians) and lower level managerial staff in all NHS hospitals was (and is) set at national level (with some regional uplifts) by a public sector pay review body and varied little across hospitals.

[8]Non-FT hospitals had to include a representative of the central government regulator.

[9]The remuneration committee is composed of at least three independent non-executive directors. It decides on pay of all executive directors and is to position its NHS FT relative to other NHS FTs and comparable organizations (Monitor 2014). Boards of non-FTs were more constrained in their decisions on pay of both executive and non-executive directors and had to follow regulator guidance. For CEOs see `https://improvement.nhs.uk/resources/supporting-providers-executive-hr-issues/` and for Chairs and non-executive directors see `https://improvement.nhs.uk/resources/terms-and-conditions-nhs-trust-chairs-and-non-executive-directors`. Executive and non-executive directors of FT hospitals are more highly paid than directors of non-FT hospitals.

3 Data

Our analysis is based on information derived from various administrative data sources, which we have brought together for the first time. We obtained data on executive director pay from the NHS Boardroom Pay Reports published by IDS Incomes Data Services for 2000/01 to 2010/11 and we extended these by hand-collecting data on director pay from hospitals' annual reports for 2011/12 to 2013/14. These reports provide data on salary, taxable benefits and total remuneration of executive directors for nearly all NHS hospitals. We then match the director pay data to hospital production measures.

Variable definitions and details of the sources are in Appendix A. In this section, we present executive board composition, summary statistics on our hospital production measures and the director pay data and describe the movement of directors across hospitals, which we rely on to estimate director effects in hospital production and pay.

3.1 Board composition

The core executive director positions present on all hospital boards are CEO, Medical Director, Nursing Director, Finance Director and HR Director.[10] In the later years of our panel we also regularly observe a Chief Operating Officer. Additionally, there is a range of other positions such as Director of Facilities and Estate Development or Director of Information Management and Technology, which we categorize in what follows as "Other".

Over the period covered by our sample, the average board has just under six members, who serve on average for just over three years. Each year, between 12 to 25% of hospitals have a change of CEO. At least 20 and up to 30% of hospitals experience a change in Medical Director every year. Turnover rates are similar for the positions of Nursing Director and Finance Director. Rates are more variable over the sample period for HR Director and Chief Operating officer.[11] Taken together, every year between 50 and up to 80% of hospitals had a change in at least one of the core executive director positions.

[10]The CEO of an NHS hospital is known as the Chief Executive, but the role is that of a CEO.

[11]Figure W-1 in Web Appendix W-1 shows for each of the core board positions the annual proportion of hospitals with a director turnover event. The figure is based on our full dataset, which includes Medical Directors and for the other board positions director-years where the director is present for only part of the year. The sample used in all our econometric analyses excludes these observations for reasons explained below.

3.2 Hospital Production Measures

We have collated a rich set of production measures at the hospital level for the financial years 2000/01 to 2013/14.[12] The NHS made these data publicly available as part of the more general reforms. Thanks to this policy of transparency, we can access a wide range of data on hospital production, including measures of inputs, throughputs (e.g. access to care metrics such as waiting times, which are important in a system where care is rationed), outputs (financial performance and measures of the quality of clinical care) and staff job satisfaction.

While directors may affect all of these measures, the reform model followed by successive governments has meant that a subset of these have been high profile targets for hospital managers in the NHS. These have not necessarily stayed the same over our sample period, as governments have changed their focus once targets for one aspect of hospital production were judged to have become less salient to voters. In the period we study, the most high profile targets were waiting times for elective care (for which there have been a series of targets in operation since 2000)[13] and financial performance (the operating surplus)[14] of hospitals. Waiting times have been a particularly important political target as the NHS rations excess demand by means of waiting lists and these are seen by the public as a measure of NHS failure when they reach long levels (Propper et al. 2010). Financial performance is also key, as all care is funded from the public purse. Both these measure were used by the NHS regulator to assess whether a hospital qualified for Foundation Trust status, which give the Board greater autonomy in terms of making large capital investments. As noted above, Board directors could be, and were, dismissed for not achieving these targets.

Other important targets reflected successive governments' general concerns over NHS expenditure and 'value for money' and were important issues for the NHS over a number of years. These targets included increasing the number of operations carried out as day cases (i.e. without overnight stay) and decreasing the average length of stay.[15] There was less

[12] Technically, these data are available at NHS hospital trust level. For readability we refer to NHS hospital trusts as hospitals. The financial year runs from 1 April to 31 March.

[13] In 2000, a policy document set out a target of a maximum waiting time for inpatient treatment of 6 months by 2005 (Department of Health 2000). In 2004, after progress had been made in reducing waiting times, a further target was set of reducing the waiting time from GP referral to hospital treatment to 18 weeks by 2008 (Department of Health 2004).

[14] Throughout our study period, hospitals were required to "ensure that its revenue is not less than sufficient, taking one financial year with another, to meet outgoings properly chargeable to revenue account" (National Health Service and Community Care Act 1990 and National Health Service Act 2006). This requirement is known as the breakeven duty. It is commonly interpreted to mean that over a three-year period hospitals' income must match their expenditure (National Audit Office 2004).

[15] In 2000, a policy document set out a target of 75% of elective surgery to be performed as day cases

Table 1: Descriptive statistics for hospital production measures and control variables

	Obs.	Mean (SD)	Mean (SD) of variable in 2000	2006	2013
Surplus (£000)	2,042	-2,240	461	-1,000	-5,526
		(16,134)	(1,990)	(9,440)	(23,748)
Waiting time,	2,003	69.1	93.9	75.4	49.1
mean (days)		(28.6)	(28.8)	(19.4)	(9.7)
Day cases (%)	2,031	30.9	29.5	29.6	34.1
		(7.9)	(7.2)	(7.3)	(8.1)
Length of stay,	2,022	4.94	6.13	4.67	4.28
mean (days)		(1.29)	(1.75)	(0.82)	(0.94)
MRSA rate	1,739	10.1	15.8 (2001)	16.0	2.55
(per 10,000 bed days)		(8.32)	(9.24)	(6.88)	(1.66)
Staff job satisfaction	1,585	3.47	3.47 (2003)	3.38	3.61
(1=dissatisfied, 5=satisfied)		(0.10)	(0.08)	(0.07)	(0.08)
Foundation Trust (%)	2,042	30.0	0	24.2	59.4
Year of merger (%)	2,042	1.67	7.52	0	1.40
Years since merger	2,042	1.08	0	0.90	2.40
		(2.75)	(0)	(1.92)	(4.64)
Acquisition (%)	2,042	1.03	0	0.65	4.90
Beds	2,042	731	748	733	692
		(398)	(430)	(397)	(359)
Technology index	2,042	0.38	0.29	0.39	0.43
		(0.23)	(0.23)	(0.22)	(0.22)
Patients aged 0 to 14 (%)	2,042	13.8	14.5	13.9	13.0
		(13.5)	(12.5)	(13.6)	(14.1)
Patients aged 60 to 74 (%)	2,042	21.0	20.7	20.4	22.2
		(6.22)	(6.4)	(6.0)	(6.3)
Patients aged 75+ (%)	2,042	21.2	18.9	20.4	23.7
		(6.7)	(6.7)	(6.5)	(7.0)
Male patients (%)	2,042	44.0	44.2	43.8	44.6
		(5.2)	(4.5)	(5.3)	(5.1)

SD = standard deviation. Definitions and sources of all variables in Table A-1 in Appendix A.

focus on clinical outcomes for much of the period we study, but reducing hospital acquired infections (meticillin-resistant Staphylococcus aureus [MRSA] rates) was an important governmental concern during the period, as a number of reports drew attention to rising levels in the early 1990s.[16]

Table 1 presents descriptive statistics for the five targeted hospital production measures and staff job satisfaction. The number of observations for each variable is determined by data availability. The surplus variable provides the most comprehensive coverage as it is available for all a 14 sample years for nearly all hospitals, resulting in 2,042 observations. Financial performance plummeted over our sample period, moving from an average surplus of £461,000 in 2000 to an average deficit of £5,526,000 in 2013. On the other hand, there were also improvements, such as sector wide falls in waiting times (the time between decision to admit and actual admission) from 94 days in 2000 to 49 days in 2013, and the meticillin-resistant staphylococcus aureus (MRSA) rates dropped from 16% in 2001 to 3% in 2013. Similarly, length of stay declined from 6 days to 4 days, while the number of day cases rose from just under 30% to just under 35% of admissions. As well as changes in means, the data also show a stark reduction in the variance of these variables over time.

3.3 Control Variables

We combined the data on hospital production with data on time-varying hospital characteristics, which we include as control variables in our regressions. They include governance measures, capital measures and case-mix (patient severity) measures. Table 1 presents descriptive statistics for the hospital-level control variables.

The proportion of hospitals who achieved Foundation Trust status steadily increased over our sample period, reaching 60% in 2013. There is also consolidation–mergers between NHS hospitals–over our sample period. Over half the NHS acute hospitals that existed in 1997 had been involved in some kind of merger or reconfiguration with other NHS hospitals by the end of 2003 (Gaynor et al. 2012). Consolidation meant that NHS hospitals grew in size, providing services from a number of sites in the same local area. All consolidation was within the NHS. There are no NHS hospital chains. On average, each year 1.7% of hospitals in our sample had just been created through a merger. Following a merger, the merged entity was often given a new NHS code. In these cases, we treat each

(Department of Health 2000). A key aim of increasing the number of day cases was to reduce length of stay to free up capacity to reduce waiting times.

[16] In 2004 the Department of Health introduced a target to reduce MRSA bloodstream infections across all NHS acute hospitals by 50% by 2008 (National Audit Office 2009).

new code as a separate hospital in our analysis– that is, two hospitals that merge and the newly merged entity are considered as three separate hospitals.[17] Mergers in which a much larger hospital absorbed a smaller hospital and kept its name and NHS code are captured by an acquisition dummy variable.

As a result of consolidation, the number of beds initially increased in our sample period, but then decreased as efficiency improvements in care delivery were achieved, as indicated by the decline in length of stay and the increase in the day case rate. Case-mix became more challenging over our sample period, with the proportion of older patients steadily increasing.

3.4 Pay Data

To ensure comparability, we drop from the pay data all observations that refer only to part of the financial year (for example, because an executive director left the hospital at some point during the year).[18]

Table 2 presents descriptive statistics for total pay, i.e. salary, benefits and in some cases bonuses. We show the overall mean and standard deviation as well as the mean at the beginning, in the middle and at the end of our sample period. These data show that the increased emphasis on the role and responsibilities of senior managers brought by the reforms were accompanied by significant changes in remuneration, both in terms of growth and variance of pay across directors. Managerial pay grew significantly, both relative to the level at the beginning of the 2000s and relative to the level of pay for clinical staff and middle managers. For CEOs average pay (adjusted for inflation) went from £98,000 in 2000 to £138,000 in 2013. Average pay of executive directors other than the CEO also increased but less steeply.

To examine in more detail the evolution of managerial pay over time, Figure 1 plots CEO pay and the pay of other executive directors over our sample period of 2000 to 2013, together with the mean pay of nurses, consultants (senior physicians) and middle managers. Over this period CEO pay was, not surprisingly, higher than pay of other NHS employees, but also increased faster. The increase in CEO pay was also accompanied by an increase in its variance. The difference between the 10$^{\text{th}}$ and the 90$^{\text{th}}$ percentile

[17] This choice has implications for the identification of managerial moves across hospitals. A manager would be considered as moving to a different hospital even if all that happened was a legal consolidation with another hospital. Therefore, when we investigate the portability of director effects by examining the persistence of director effects across different hospital spells for the subset of directors observed at more than one hospital, we exclude moves between hospitals that are due to a merger. However, we also report results for the sample of all moves, including moves due to a merger.

[18] The sample used in all econometric analyses excludes director-years where the director is only present for part of the year.

Table 2: Descriptive statistics for directors' pay

	Obs.	Mean (SD)	Mean (SD) of variable in 2000	2006	2013
Total pay, CPI adjusted (£)	7,710	92,300	97,107	90,776	99,984
		(26,704)	(14,752)	(25,290)	(28,730)
By board position:					
CEO	1,606	125,994	97,535	126,668	137,628
		(27,923)	(14,523)	(24,589)	(28,189)
Finance Director	1,309	94,276	88,600	94,152	102,176
		(17,904)	(0)	(16,234)	(17,432)
Chief Operating Officer	684	87,231	-	85,909	92,560
		(18,943)	-	(15,254)	(16,313)
Nursing Director	1,270	80,726	-	80,692	87,118
		(15,358)	-	(14,372)	(15,619)
HR Director	936	77,342	-	74,997	82,004
		(14,630)	-	(14,932)	(12,519)
Other	1,905	79,424	66,200	79,125	83,151
		(16,854)	(0)	(15,727)	(18,535)

SD = standard deviation. Total pay includes salary, benefits and bonuses. Means of total pay in 2000 are based on only 1 observation each for Finance Director and Other. Definitions and sources of all variables in Table A-1 in Appendix A.

(the lighter shaded area in the Figure) increased from £40,000 in 2000 to £65,000 in 2013 and at the top of the distribution CEO pay increased from £120,000 in 2000 to £175,000 in 2013. Pay for executive directors other than the CEO increased less steeply but also shows an increase in its variance (the darker shaded area in the Figure). In levels it was comparable to the pay of senior doctors.[19] While the growth in pay did not compensate for differences in pay levels relative to CEOs in the UK corporate sector and hospital executives in the US,[20] these trends put the remuneration packages of NHS CEOs at the top end of the compensation distribution of the UK public sector and of UK public service providers more generally. We provide an in depth comparison of hospital managers' pay with executive pay at UK public service providers in Web Appendix W-2.

3.5 Identifying Movements of Directors across Hospitals

From the pay data we identify movements of directors across hospitals, which we exploit to examine the impact of directors on hospital production net of hospital characteristics, as detailed in Section 4. On average, we observe directors for a period of little over than 5 years in total, spent across 1.4 hospitals. Figure 2a presents the distribution of hospital spells per director. It shows that we observe a sizeable number of directors in two or more NHS hospitals. Figure 2b presents the distribution of the number of years per hospital spell. While many spells last only one year, the majority of spells have a longer duration. The average tenure per hospital spell is 3.7 years for all directors and 4.1 years for the subset of CEOs.[21]

4 Methods

4.1 Two-way fixed effects model

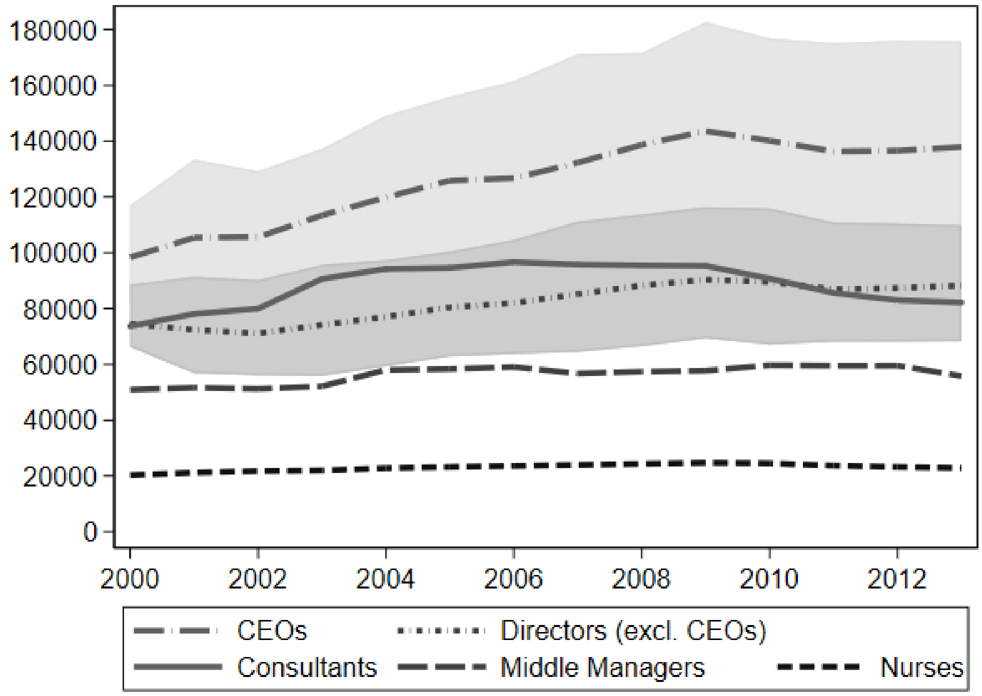
To isolate the importance of hospital managers in production and pay we estimate a two-way fixed effects model pioneered by Abowd et al. (1999). This model allows us to

[19]NHS employees also receive generous pension benefits which are excluded from this analysis.

[20]Bell & Van Reenen (2016) report mean total compensation of CEOs of the top 300 UK primary-listed companies increased from £900,000 in 1999 to £1,900,000 in 2014. These remuneration packages are larger by an order of magnitude. Joynt et al. (2014) report that mean compensation of CEOs of US non-profit hospitals was $596,000 (approximately £400,000) in 2009. The majority of CEOs in their sample served at hospitals with fewer than 300 beds, well below even the 25$^{\text{th}}$ percentile of 446 in our sample. Similarly, figures Joynt et al. (2014) report for the highest decile of the compensation distribution, which has the largest mean number of beds (310), show mean compensation of $2,100,000 (approximately £1,400,000).

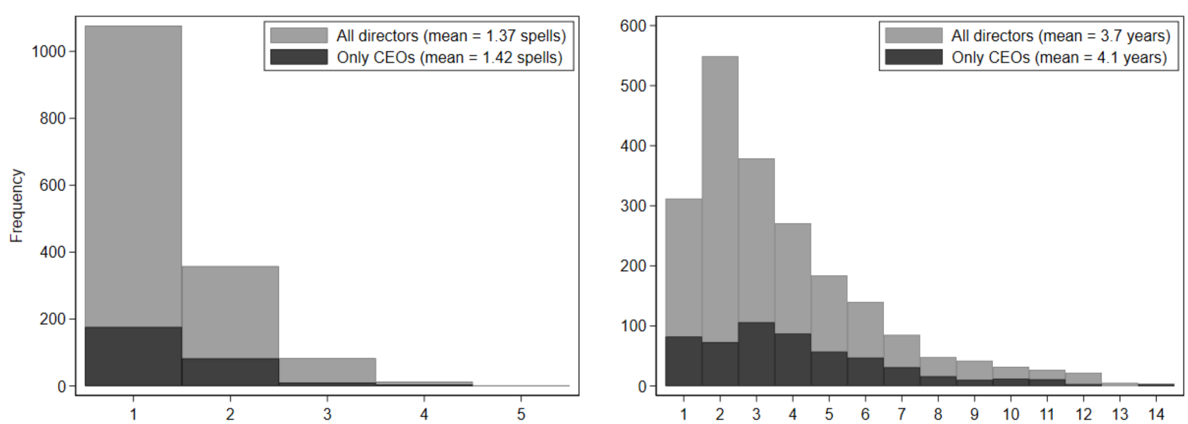
[21]Figure 2 excludes Medical Directors as we exclude them from all our estimation samples as explained in Section 4.

Figure 1: Mean annual earnings for NHS staff by job type



Note: Adjusted for inflation using Consumer Price Index, base year = 2000. Sources: CEO and Director earnings: NHS Boardroom Pay Reports and hospitals' annual reports; Consultant, middle manager and nurse earnings: NHS Staff Earnings Estimates to March 2014 - Provisional Statistics (Table 2b) (for period 2008 to 2013); Public Expenditure on Health and Personal Social Services 2009 - Memorandum received from the Department of Health containing Replies to a Written Questionnaire from the Committee, House of Commons Health Committee (Tables 73d and 75b) (for period 2000 to 2007)

Figure 2: Number of hospital spells per director and number of years per hospital spell



(a) Hospital spells per director

(b) Tenure per spell

Notes: Spells based on estimation sample for surplus. Number of all directors = 1,532; number of CEOs = 272; number of spells for all directors = 2,099; number of spells for CEOs = 538 decompose differences in hospital production measures and directors' pay into hospital fixed effects, director fixed effects, time varying observable hospital characteristics and residual variation.

For the hospital production measures we estimate equations of the following form:

$$production_{i(j,t)jt} = \boldsymbol{X}'_{jt}\boldsymbol{\beta} + \lambda_t + \alpha_i + \psi_j + \varepsilon_{i(j,t)jt} \tag{1}$$

The left-hand side variable, $production_{i(j,t)jt}$, is a production measure of hospital j in financial year t. The function $i(j,t)$ maps hospital j to director i in financial year t. Through this mapping director i gets assigned a hospital production measure, i.e. we assign firm-level production measures to individual directors. This follows recent work (e.g. Fenizia (2022), Metcalfe et al. (2023)). In our case, as there are several directors per hospital, the same $production_{jt}$ will be assigned to all the directors who are present at hospital j at time t. $\boldsymbol{X}_{jt}$ is a vector of the following time-varying observable hospital characteristics: foundation trust status, year of merger, years since merger, beds, technology index, case mix measures (patients aged 0 to 14, patients aged 60 to 74, patients aged 75+, male patients). A full set of financial year effects, λ_t, provides non-parametric control for trends in pay that are national in scope. α_i denotes the director effects, ψ_j the hospital effects and ε_{ijt} represents the error term.

The error term in equation (1), $\varepsilon_{i(j,t)jt}$, can be decomposed into a match-specific component, $\eta_{i(j,t)}$; a unit root component, ξ_{jt}; and a transitory error, $\nu_{i(j,t)jt}$ (Card et al. 2013),

$$\varepsilon_{i(j,t)jt} = \eta_{i(j,t)} + \xi_{jt} + \nu_{i(j,t)jt}. \tag{2}$$

The identification of hospital and director fixed effects relies on the assumption that the assignment of directors to hospitals is conditionally mean-independent of past, present, and future values of $\varepsilon_{i(j,t)jt}$. This assumption allows directors to be assigned to hospitals based on the permanent components of managerial ability (α_i) and hospital effects (ψ_j), permitting sorting on these fixed effects. However, it excludes the possibility of directors being assigned to hospitals based on their match-specific component ($\eta_{i(j,t)}$), the drift in hospital j's production (ξ_{jt}) or transitory shocks to hospital production ($\nu_{i(j,t)jt}$). If managers were to sort based on these factors, it would result in biased and inconsistent estimates of the fixed effects due to endogenous mobility.

We estimate the following model for executive directors' pay:

$$pay_{ijt} = \boldsymbol{X}'_{jt}\boldsymbol{\beta} + \gamma\, tenure_{ijt} + \boldsymbol{Z}'_{ijt}\boldsymbol{\delta} + \lambda_t + \alpha_i + \psi_j + \varepsilon_{ijt} \tag{3}$$

The left-hand side variable, pay, denotes pay of director i at hospital j in financial year t. $\boldsymbol{X}_{jt}$ is the same vector of time-varying observable hospital characteristics as in Equation 1. $tenure_{ijt}$ is the tenure of director i at hospital j in financial year t. $\boldsymbol{Z}_{ijt}$ is a vector of dummy variables indicating the board level position of director i at hospital j in financial year t (CEO, Finance Director, COO, Nursing Director, HR Director, Other Director). λ_t, α_i and ψ_j are the year effects, director effects and hospital effects, respectively. $\varepsilon_{i(j,t)jt}$ represents the error term.[22] For identification, the same argument applies to equation (3) as for hospital production.

Connected Sets We identify director effects separately from hospital effects by leveraging the approach proposed by Abowd et al. (1999). Between hospital mobility of the executive directors is essential for the identification of the hospital effects in directors' pay. The hospital effects in pay can only be estimated within sets of hospitals connected by director mobility. Identification of hospital effects in hospital production measures, on the other hand, does not require director mobility because the outcome variable is measured at the hospital level. However, within a set of hospitals connected by director mobility, we can identify both hospital effects and director effects in hospital production measures. If we were to attempt estimation of both hospital effects and director effects using the full sample rather than within a connected set, some of the director effects would be dropped due to perfect collinearity with the hospital effects.

Thankfully, the majority of the hospitals in our data set are connected by director mobility, resulting in just one very large connected set: on average, around 8,700 observations from around 2,100 directors at around 200 hospitals are inside the connected set while only around 160 observations, from 47 directors at 17 hospitals are outside the connected set. This is in contrast to the data used in other studies of organisations in the public and private sector. For example, the data used in Fenizia (2022) and Metcalfe et al. (2023) consist of many connected sets, so both studies tend to limit their analyses to the largest connected set(s).[23] One possible concern when there is such fragmentation of the connected sets is that the largest connected set might not be representative of the full sample.

[22]We exclude Medical Directors from the estimation sample as only some of their remuneration is recorded in the executive pay data. This is because the majority of Medical Director remuneration is for clinical work, which is excluded from the directors' data. On average, Medical Directors salaries in the directors' data are lower than those of other directors. To be consistent, we also exclude Medical Directors from the estimation samples for our hospital production measures.

[23]Best et al. (2023) is an exception to this with a very large connected first set.

Limited mobility bias In finite samples there may be limited mobility bias. This results in a spurious negative correlation between the two dimensions of estimated fixed effects (Andrews et al., 2008). To address this, we use a subset of the largest connected set to compute the leave-one-out estimator proposed by Kline et al. (2020) to obtain unbiased estimates of the covariance between the hospital and director effects. The leave-one-out estimator requires observations in the connected set to still be connected after any director-hospital combination is removed (details are in Web Appendix W-3). Table W-1 presents descriptive statistics for the connected and the leave-one-out connected sets. On average, around 7,700 observations coming from around 1,500 directors at 174 hospitals are in the leave-one-out connected set. Comparisons of the means of the hospital production measures and directors' pay in the connected set and the leave-one-out connected set suggests there are no systematic differences between the two sets. Tables W-2 and W-3 present descriptive statistics comparing the movers and the non-movers in the connected set and the leave-one-out connected set. Table W-2 shows that the means of the hospital production measures are the same for both movers and non-movers. For directors' pay Table W-3 shows differences between movers and non-movers, with movers' pay being around 5% higher higher than non-movers' pay.

Variance Decomposition We assess the importance of individual directors in accounting for differences in hospital production and directors' pay relative to hospital effects and other hospital-specific time-varying characteristics by calculating the proportion of the variance in the hospital production measures and in pay that is explained by the covariates, the hospital effects and the director effects.[24]

Portability To check if our estimated director effects capture the portable component of directors' impact on hospital production and directors' pay, we adapt a robustness test in Bertrand & Schoar (2003) for our two-way fixed effects model.[25] First, we estimate

[24]The proportions of the variance explained by the hospital effects and the director effects are for the hospital production measures $[\text{Cov}(production_{i(j,t)jt}, \hat{\psi}_j)/\text{Var}(production_{i(j,t)jt})] \times 100$ and $[\text{Cov}(production_{i(j,t)jt}, \hat{\alpha}_i)/\text{Var}(production_{i(j,t)jt})] \times 100$, and for pay $[\text{Cov}(pay_{ijt}, \hat{\psi}_j)/\text{Var}(pay_{ijt})] \times 100$ and $[\text{Cov}(pay_{ijt}, \hat{\alpha}_i)/\text{Var}(pay_{jt})] \times 100$. To obtain the variance proportion explained by the covariates, we first calculate $\widehat{production}_{i(j,t)jt} = \boldsymbol{X}'_{jt}\hat{\boldsymbol{\beta}} + \hat{\lambda}_t$ and $\widehat{pay}_{ijt} = \boldsymbol{X}'_{jt}\hat{\boldsymbol{\beta}} + \hat{\gamma} tenure_{ijt} + \boldsymbol{Z}'_{ijt}\hat{\boldsymbol{\delta}} + \hat{\lambda}_t$ and then use these predictions to obtain the covariances needed to calculate the variance proportions: $[\text{Cov}(production_{i(j,t)jt}, \widehat{production}_{i(j,t)jt})/\text{Var}(production_{i(j,t)jt})] \times 100$ and $[\text{Cov}(pay_{ijt}, \widehat{pay}_{ijt})/\text{Var}(pay_{ijt})] \times 100$, respectively.

[25]We examine the association of hospital-by-director effects, which allows for all covariates. Bertrand & Schoar (2003) examine the correlation between the mean of residuals at a manager's first and second firm, with the residuals coming from a regression of the outcome variable on time-varying firm characteristics, year effects and firm effects.

production as a function of our covariates and hospital-by-director effects, resulting in the following equation for the hospital production measures:

$$production_{i(j,t)jt} = \boldsymbol{X}'_{jt}\boldsymbol{\beta} + \lambda_t + \eta_{ij} + \varepsilon_{i(j,t)jt} \tag{4}$$

The η_{ij} are the hospital-by-director effects.[26]

The equivalent equation for managerial pay is:

$$pay_{ijt} = \boldsymbol{X}'_{jt}\boldsymbol{\beta} + \gamma\, tenure_{ijt} + \boldsymbol{Z}'_{ijt}\boldsymbol{\delta} + \lambda_t + \eta_{ij} + \varepsilon_{ijt} \tag{5}$$

Second, we use these estimated hospital-by-director effects to examine the association between the hospital-by-director effects for directors who move between hospitals. Using n to denote director i's n-th spell in our sample, we run regressions of the following form:

$$\eta_{in} = \rho_1 + \rho_2\eta_{in-1} + \varepsilon_{in} \tag{6}$$

A positive association between the hospital-by-director effects across different spells (captured by the coefficient ρ_2) would suggest that the director effects are portable. Should we find no positive association between the hospital-by-director effects of directors moving between hospitals, we would be concerned that the director effects α_i in Equations 1 and 3 are just shocks specific to each hospital-director combination rather than permanent director effects.[27] In addition to the regression coefficient ρ_2 we report the Pearson correlation coefficient $\rho(\eta_{in}, \eta_{in-1})$ to allow comparisons of the strength of the association across the different hospital production measures. The correlation coefficient also allows us to compare the level of portability of director effects in hospital production to the level of portability of director effects in pay.

4.2 Tests of identification assumptions of the AKM model

As discussed above, identification of the director fixed effects in hospital production requires director mobility and relies on a strong exogeneity assumption that prohibits any sorting of directors and hospitals based on the match-specific component, $\eta_{i(j,t)}$ in equa-

[26] In the case of two directors who are at hospital j for exactly the same years t, the estimated hospital-by-director η_{ij} effects will be the same because the values for the hospital production measure $production_{i(j,t)jt}$, the covariates $\boldsymbol{X}_{jt}$ and the financial year effect λ_t are exactly the same. The η_{ij} are essentially a hospital-period-specific effect.

[27] For directors moving between hospitals the α_i would be the average of shocks specific to each of their hospital-director combinations. For directors observed at only one hospital, the α_i would be the shock specific to the their one hospital-director combination.

tion (2), the unit root component, ξ_{jt}, or the transitory shocks, $\nu_{i(j,t)jt}$. Any of these three forms of endogenous mobility would result in inconsistent estimates of the fixed effects. We summarise here the checks we performed to establish the validity of the identification assumptions underlying the AKM model; details of the tests are in Appendix B.[28]

Sorting on match component We check for sorting based on the match component by comparing the gains in hospital production for directors moving from low to high performing hospitals to the losses of directors moving from high to low performing hospitals and by comparing the fit of the two-way fixed effects model in equation (1) to the fit of the fully saturated model in equation (4) in which the separate hospital and director effects are replaced with hospital-by-director effects. We find no evidence of endogenous mobility.

Sorting on unit root component A second concern about the independence of the error term arises if directors who are on a particularly positive outcome trend — those who increase an output before a move - are more likely to move to hospitals with higher output, while those on a negative output trend are more likely to move to hospitals with lower output. We find no clear direction in the trends prior to moves for any of the hospital production measures.

Identification of hospital fixed effects in directors' pay The same issues arise for identification of director and hospital effects in directors' pay. We therefore undertake the same tests of identification assumptions for directors' pay. We find no evidence of sorting on the match component or the unit root component.

5 The (lack of) impact of directors on hospital performance

5.1 Variance Decomposition

We begin by showing the proportions of the variance accounted for by the hospital and director effects, respectively, in hospital production and pay, using Equations 1 and 3. Table 3 presents details of the estimation sample for each outcome variable and the results.

The first row of each panel in Table 3 shows the proportion of variance accounted for by the covariates, the hospital and the director effects in the hospital production measures.

[28] We follow Card et al. (2013); for a recent application, see Diaz et al. (2024).

Table 3: Two-way fixed effects models of hospital production measures and directors' pay

					Proportion of variance in outcome variable explained by:			
	Obs.	Hospitals	Directors	Movers	Co-variates	Hospital effects	Director effects	Re-siduals
Surplus								
All directors	7,736	174	1,532	455	2.71%	25.0%	7.92%	64.3%
		Correlation of hospital and director effects:				-0.41		
Only CEOs	1,621				2.26%	26.8%	5.70%	65.2%
Waiting times								
All directors	7,569	174	1,515	447	54.6%	29.5%	6.0%	9.9%
		Correlation of hospital and director effects:				-0.12		
Only CEOs	1,591				53.0%	30.3%	5.4%	11.2%
Day cases								
All directors	7,689	174	1,530	455	16.6%	74.0%	1.39%	7.96%
		Correlation of hospital and director effects:				-0.09		
Only CEOs	1,612				*20.7%*	*73.9%*	*-2.15%*	*7.54%*
Length of stay								
All directors	7,666	173	1,521	453	42.3%	42.1%	4.03%	11.6%
		Correlation of hospital and director effects:				-0.18		
Only CEOs	1,599				44.1%	39.6%	4.91%	11.4%
MRSA rate								
All directors	6,868	144	1,388	367	53.9%	22.2%	8.73%	15.1%
		Correlation of hospital and director effects:				-0.28		
Only CEOs	1,384				51.8%	23.4%	8.90%	15.9%
Job satisfaction								
All directors	6,353	156	1,335	374	43.8%	31.2%	5.97%	19.0%
Correlation of hospital and director effects (not bias corrected):						-0.26		
Only CEOs	1,241				44.9%	29.0%	5.54%	20.5%
Directors' pay								
All directors	7,710	173	1,528	453	40.7%	14.0%	37.8%	7.5%
		Correlation of hospital and director effects:				0.13		
Only CEOs	1,606				27.3%	20.7%	35.3%	16.7%

Correlation of hospital and director effects estimated using leave-one-out estimator by Kline et al. (2020) except for job satisfaction as leave-one-out estimate not defined. The variance proportions for only CEOs are obtained by repeating the variance decomposition calculations described in Section 4.1 for the subset of observations with the job title CEO.

The second row uses the results from the regression reported in the first row to calculate the variance decomposition for the subset of observations with the job title CEO. The share accounted for by hospital effects is relatively large, ranging from 22% for the MRSA rate to 74% for day cases. The variance in production across hospitals is thus strongly associated with both time varying factors (though these vary across measures) and fixed factors, such as location, whether a hospital is a teaching hospital, and its capital stock. Conversely, the proportion of variance explained by the director effects is much smaller and ranges from 1% for day cases to 9% for the MRSA rate. This suggests that production measures depend on fixed factors at the hospital level, such as location and age of capital. We find very similar results when we examine only CEOs, indicating that they do not have a strongly different effect from other members of the top team on production.

However, the decomposition for directors' pay shows very different results: the directors' effects account for nearly 40% of the variance in pay, with a similar share for CEOs only, while the share of variance accounted for by the hospital effects is much smaller (less than 15% for all directors and just over 20% for just the CEOs).

The second row of each panel shows the bias-corrected correlation between the hospital and the director effects. The correlations are negative for all hospital production measures. In contrast, the correlation in pay is positive though not large.[29]

5.2 Portability

The results indicate that directors account for a very small fraction of the variation in performance across hospitals. This result is confirmed by the analysis of the persistence of director effects across different spells – what we call the portability of directors' effects on hospital performance – which we do by examining the association between the hospital-by-director effects estimated in Equations 4 and 5. If director effects are portable, we would expect these hospital-by-director shocks to be correlated across hospitals. We observe around 430 directors at more than one hospital, most of them at two different hospitals but some at up to 4 different hospitals.

Table 4 shows very little evidence of portability of these match-specific effects for most of the hospital production measures, with the exception of waiting times and MRSA rates, which are driven by directors other than CEOs. Results from separate regressions for each of the board positions in Table W-4 in Web Appendix W-5 show that the positive correlation coefficient for waiting times is due to portability for COOs and Finance

[29]The positive association we find for pay contrasts with the result in the literature of a negative correlation between worker and firm effects in pay. These negative correlations may partly be driven by a statistical artefact which our use of the leave-one-out estimator overcomes (Kline et al. 2020).

Table 4: Portability regressions estimating the association between the two or more hospital-by-director effects available for movers

	Surplus	Waiting times	Day cases	Length of stay	MRSA rate	Job satis-faction	Directors' pay
All directors							
Regress. coeff.	-0.002	0.046*	0.024	0.050	0.091***	0.057	0.72***
	(0.09)	(0.026)	(0.042)	(0.032)	(0.030)	(0.049)	(0.052)
Correl. coeff.	-0.001	0.08	0.025	0.067	0.14	0.057	0.52
Obs.	532	523	532	529	449	426	528
Only CEOs							
Regress. coeff.	0.052	-0.026	-0.021	-0.007	0.026	0.112	0.73***
	(0.13)	(0.047)	(0.075)	(0.058)	(0.059)	(0.087)	(0.088)
Correl. coeff.	0.030	-0.04	-0.021	-0.009	0.037	0.11	0.53
Obs.	175	174	175	173	146	131	174

Standard errors in (parentheses). The hospital-by-director effects for the hospital production measures are the η_{ij} in Equation 4 and the hospital-by-director effects for pay are the η_{ij} in Equation 5. *Significant at 10%, **significant at 5%, ***significant at 1%

Directors and the portability for MRSA rates is driven by Finance Directors and Nursing Directors. In contrast, there is much greater portability in pay: the correlation coefficient for hospital-by-director effects across two moves is over 0.7 for CEOs and is similar for all board members.[30]

5.3 Short tenures

The evidence of a limited role for directors in driving performance differentials across hospitals may be related to a salient feature of the NHS managerial labour market: that directors rotate very frequently and have relatively short tenures (3.7 years on average). This implies that directors may not have time to address long-standing differences across hospitals in production, which are evidenced by the much larger share of variance that hospital fixed effects have in production than director fixed effects.

In Table 5 we investigate this hypothesis by examining the association between the

[30] We can assess portability for the subset of directors observed at more than one hospital. Some directors are observed at more than one hospital because their hospital merged with another hospital into a new entity and they stayed on as director in the new entity. Thus, they appear to have moved to another hospital. In Table W-4 we present results that exclude such moves. In Table W-5 in Web Appendix W-5 we present results for the sample that includes all moves and for the sub-sample of moves that are due to a merger. When we include moves due to a merger there is some suggestion of portability. However, repeating the analysis for the sub-sample of moves due to a merger shows that any positive associations are driven by the moves due to a merger, which are very different from moves between two completely different hospitals as the director's previous hospital makes up a large part of the new entity.

Table 5: Association between directors' total time in post at a hospital and the corresponding hospital-by-director effect (larger effect means better performance)

	Surplus	Waiting times × (-1)	Day cases	Length of stay × (-1)	MRSA rate × (-1)	Job satis-faction	Directors' pay
All directors							
Total time in post (years)	0.026***	0.031***	0.004	-0.006	0.014	0.065***	-0.033***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Obs.	2,099	2,073	2,097	2,085	1,838	1,775	2,091
Only CEOs							
Total time in post (years)	0.029*	0.014	0.016	-0.002	0.010	0.088***	-0.008
	(0.017)	(0.021)	(0.019)	(0.020)	(0.023)	(0.020)	(0.024)
Obs.	386	384	386	383	327	310	383

Standard errors in (parentheses). All regressions include a dummy variable indicating that tenure is unsure because we observe the director at this hospital in the first year of our sample period. The hospital-by-director effects are the η_{ij} in Equation 4 for the hospital production measures and in Equation 5 for directors' pay. All hospital-by-director effects have been standardized to have mean = 0 and standard deviation = 1. The hospital-by-director effects for waiting times, length of stay and MRSA rate have been multiplied by -1, so more is always better. *Significant at 10%, **significant at 5%, ***significant at 1%

hospital-by-director effects η_{ij} from Equation 4 and the total length of time the director has spent at this hospital. We repeat this for pay using the η_{ij} from Equation 5.[31] The hospital-by-director effects are standardized to allow comparisons across production measures and the hospital-by-director effects for waiting times, length of stay and MRSA rate have been multiplied by -1, so for all hospital production measures a larger hospital-by-director effect means better hospital production.

For all directors there is a strong statistically significant positive association between total time in post and the hospital-by-director effects for staff job satisfaction. For example, compared to a director who stays for only 2 years, the hospital-by-director effect for a director who stays for 6 years is associated with an increase in satisfaction of one-quarter of a standard deviation. For a director who stays for 10 years the increase is half of a standard deviation. The association is even stronger if we examine only the CEOs. For surplus and waiting times there is also a statistically significant positive association with time in post, with the effect size around half of that for job satisfaction. The association for surplus is similar for CEOs as for all directors.[32]

[31] The sample is all director-spells and each hospital-by-director effect appears only once in this sample.

[32] Results from separate regressions for each of the board positions in Table W-6 in Web Appendix W-5 show that Finance Directors and Other directors account for the association with time in post for waiting times.Table W-7 in Web Appendix W-5 presents broadly similar results for an alternative specification that uses three dummy variables to measure total time in post: 3 to 4 years, 5 to 8 years and 9 and more

The possible endogeneity of directors' total time in post makes it hard to pin down the direction of causality behind these associations–that is, better performance may allow directors to have longer tenures regardless of their direct impact on hospital performance. Regardless of the precise mechanism, however, the data suggest that directors are not compensated for longer tenures. In fact, the bottom row of Table W-6 shows that, in spite of its positive association with performance, longer tenure is associated with *lower* pay for all directors, though with different intensity across different titles. This suggests that directors may be able to earn more by moving across hospitals, rather than staying in place for longer time, a point that we examine directly in Section 6.

5.4 Endogenous Sorting of Managers to Hospitals

Finally, we examine whether the limited effectiveness of senior managers within any given spell and the lack of portability may be explained by endogenous sorting of the best directors into the most difficult hospitals. That is, directors with better performance at one hospital may be systematically hired by more challenging hospitals in their next director position. If better directors have a higher probability of being hired by more challenging hospitals, it could make it harder for these directors to replicate a positive impact across hospitals, thus explaining the lack of portability in hospital production.[33]

To explore the plausibility of this explanation, we begin by identifying hospitals which may be harder to manage because they are experiencing problems. We consider four definitions of "challenging". These are (i) having received a poor rating from the government regulator of hospitals before the director arrived at the hospital,[34] (ii) being a "new" hospital that was created through a merger at some point during our sample period, (iii) having poor financial performance, defined as being at or below the 25^{th} percentile of surplus two years before the director moved there, (iv) having poor operational performance, defined as being at or above the 75^{th} percentile in waiting times two years before the director moved there.

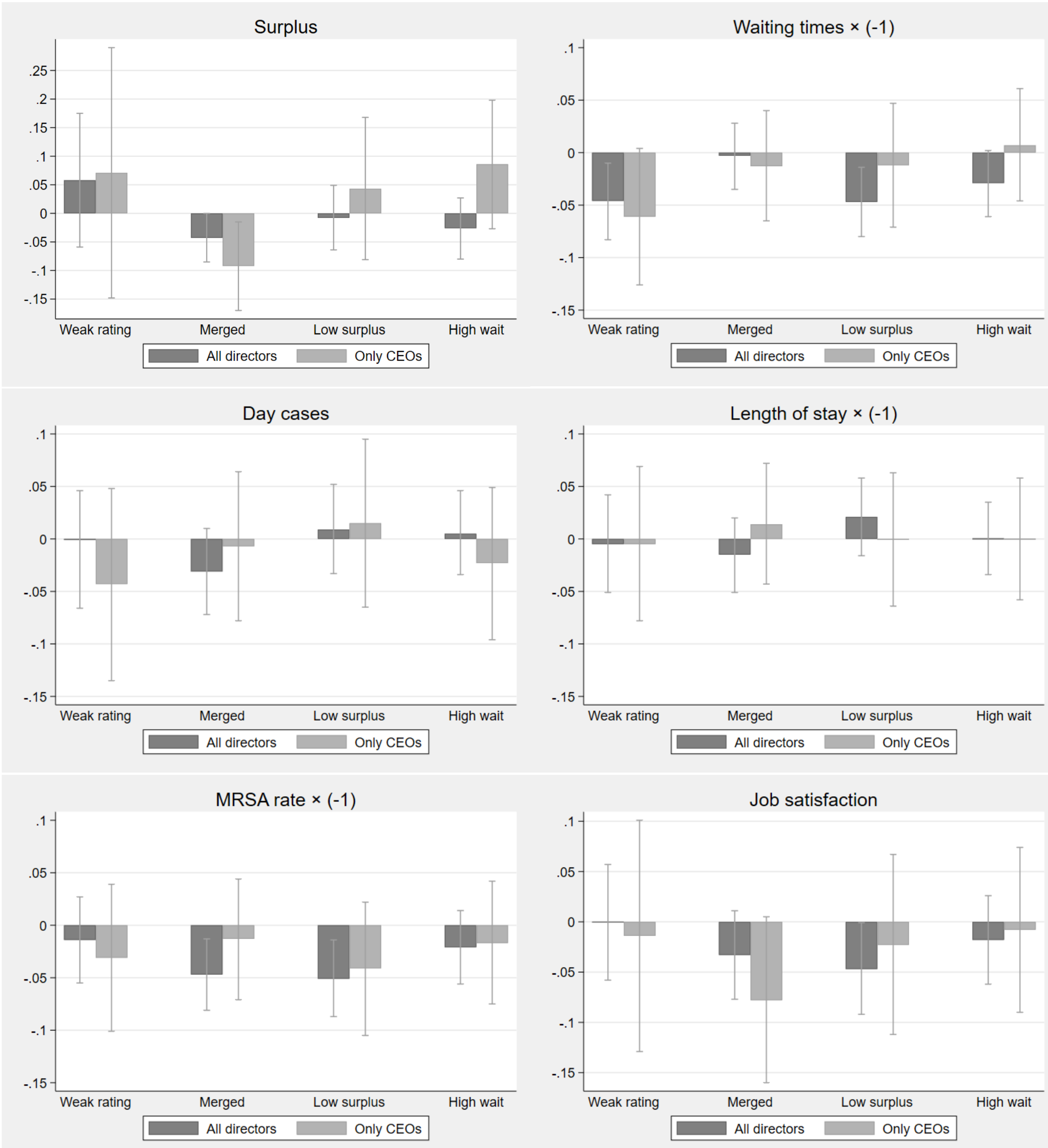
For all movers we estimate linear probability models of moving to a challenging hospital as a function of the director's hospital-by-director effect at their previous hospital, i.e. the η_{in-1} in Equation 4. The hospital-by-director effects are standardized to allow comparisons across production measures. Furthermore, the hospital-by-director effects for waiting times, length of stay and MRSA rate are multiplied by -1, so for all hospital production

years with 1 to 2 years being the omitted category.

[33]Systematic mobility between different types of hospital or types of director does not pose a threat to identification in the AKM model as long as it is captured by the hospital and director effects and our control variables.

[34]Regulator ratings were not issued each year. Details are in Appendix A.

Figure 3: Impact of hospital-by-director effect in indicated hospital production measure (larger effect means better performance) on probability of moving to a challenging hospital



Notes: Each coefficient and its 95% confidence interval is from a separate regression of an indicator of a director moving to a challenging hospital on the director's hospital-by-director effect at their previous hospital. The hospital-by-director effects are the η_{ij} in Equation 4. All hospital-by-director effects have been standardized to have mean = 0 and standard deviation = 1. The hospital-by-director effects for waiting times, length of stay and MRSA rate have been multiplied by -1, so more is always better. Weak rating: hospital received a poor rating from the government regulator before director moved there. Merged: hospital was created through a merger at some point during our sample period. Low surplus: hospital's surplus was at or below 25^{th} percentile two years before director moved there. High wait: hospital's waiting time was at or above 75^{th} percentile two years before director moved there. Percentiles calculated separately for each financial year to ensure categorisation is net of year effects.

measures a larger hospital-by-director effect means better hospital production. We run separate regressions for each of our six hospital production measures. Thus, with four definitions of challenging, we generate 24 coefficient estimates. These and their 95% confidence intervals are presented in Figure 3.

The results for all directors (the dark grey estimates) are primarily negative, with 6 of the 24 coefficient estimates being statistically significant. These negative coefficients suggest that good performers are *less* likely to move to a challenging hospital. The findings are similar for the subset of CEOs (light grey estimates) but due to the smaller sample sizes all but one of the coefficients are statistically insignificant.[35]

Conversely, we can also examine whether good performers move to prestigious hospitals. We define as "prestigious" (i) teaching hospitals, (ii) the biggest hospitals (defined by number of beds), (iii) hospitals that are Foundation Trusts (i.e. were judged by the regulator to have better performance) and (iv) winning a contract for a large capital investment at some point during the director's tenure.[36] Again, we estimate separate linear probability models for each of our six hospital production measures, resulting in 24 coefficient estimates, which are presented in Figure 4.

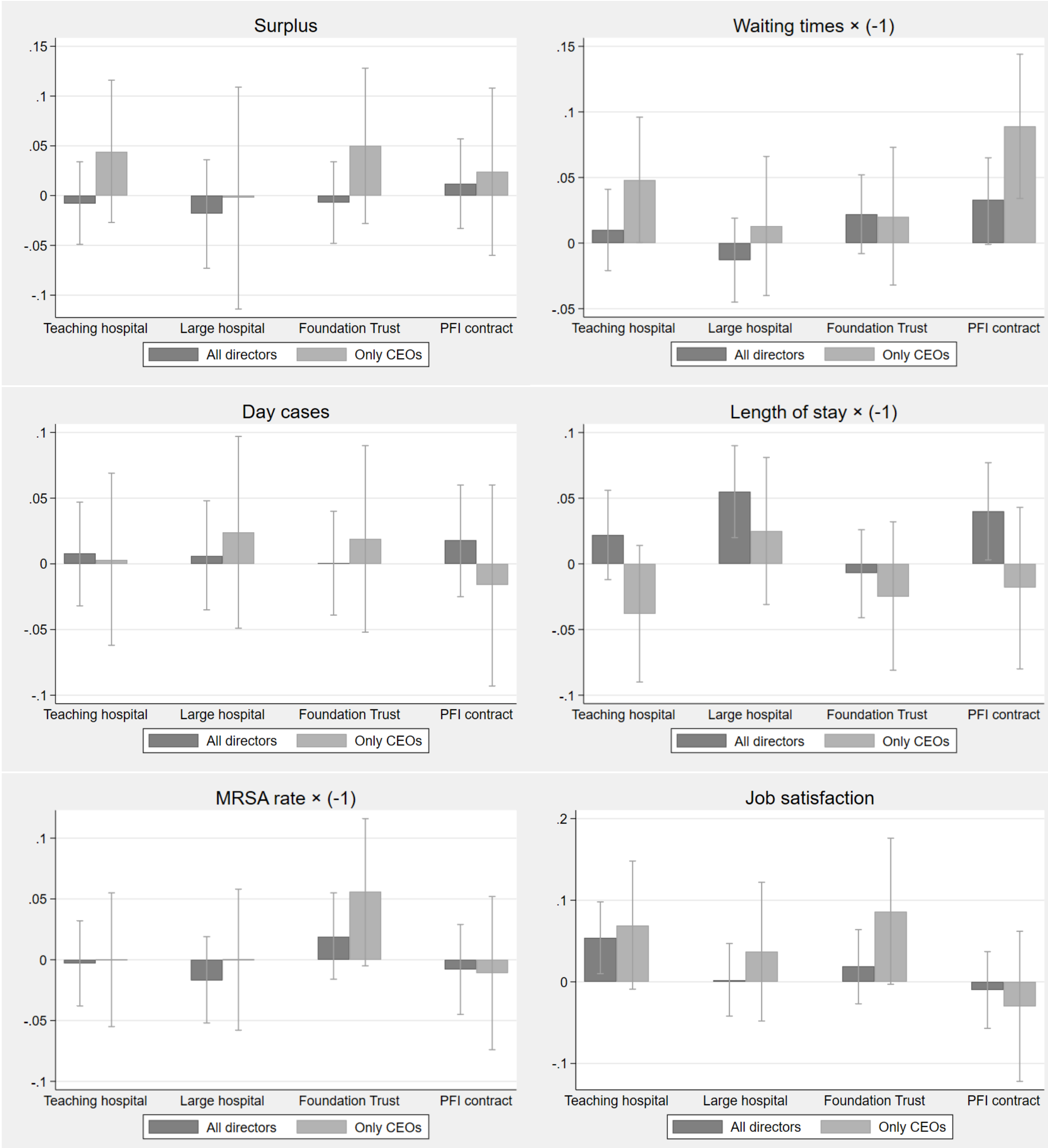
The pattern is basically the reverse of Figure 3. The bulk of the estimated effects are positive. For all directors 3 out of the 24 coefficients are statistically significant and for the subset of CEOs 2 are statistically significant.

These results suggest that the apparent lack of portability in positive performance across hospitals is unlikely to be due to the assignment of directors who performed well in one hospital to worse performing hospitals in their next move. If anything, the results show that it is more likely that a good performance in one hospital leads to being hired at a prestigious hospital rather than one that may be difficult to manage. i.e. of *positive* assortative matching between directors and hospitals.

[35]The estimation samples are similar to the ones for the portability regressions in Table W-4 as the linear probability models also use the sample of movers. Sample sizes vary because of different coverage of the four different measures of "challenging" and the six different hospital-by-director effect estimates. For surplus, which has the largest coverage in terms of the hospital-by-director effects, the sample sizes are as follows: (i) poor rating: 370 all directors, 124 only CEOs, (ii) merged hospital: 567 all directors, 181 only CEOs, (iii) low surplus: 523 all directors, 169 only CEOs, (iv) high wait: 516 all directors, 167 only CEOs. Job satisfaction has the smallest sample sizes: (i) 258/98, (ii) 440/132, (iii) 423/130, (iv) 418/129.

[36]NHS hospitals have to borrow for large capital investments from the private market. Borrowing is through vehicles with long-term fixed interest rates and long payback periods, known as private finance initiative (PFI) contracts. The right to bid for these was controlled by central government and granted partly on various past measures of performance.

Figure 4: Impact of hospital-by-director effect in indicated hospital production measure (larger effect means better performance) on probability of moving to a prestigious hospital



Notes: Each coefficient and its 95% confidence interval is from a separate regression of an indicator of a director moving to a prestigious hospital on the director's hospital-by-director effect at their previous hospital. The hospital-by-director effects are the η_{ij} in Equation 4. All hospital-by-director effects have been standardized to have mean = 0 and standard deviation = 1. The hospital-by-director effects for waiting times, length of stay and MRSA rate have been multiplied by -1, so more is always better. Teaching hospital: major or minor teaching hospital. Large hospital: hospital's number of beds was at or above 75^{th} percentile in year before director moved there. Percentiles calculated separately for each financial year to ensure categorisation is net of year effects. Foundation Trust: hospital has foundation trust status. PFI contract: hospital has a private finance initiative (PFI) contract at some point during director's tenure.

6 Pay for Performance?

The NHS reforms that gave rise to the managerial labor market examined in this paper also gave important pay setting responsibilities to local governing boards, under the premise that the autonomy to set pay would allow them to attract talent and align directors' behavior to hospital needs. The results discussed so far – limited impact on production but persistent pay differentiation across directors – raise the question of whether boards were able to fulfill this responsibility in an effective way. In this section we provide additional evidence on this point by investigating whether and how boards were able to actually pay directors for performance.

We examine this question in three ways. First, by looking at the correlation between directors' fixed effects in performance and pay. This analysis answers the question of whether pay differences across managers are broadly related to their performance throughout their career. Second, we analyse the correlation between pay and performance within specific hospital spells. This is because there may be heterogeneity in the boards' ability or willingness to adjust pay to performance, which would be lost by looking at fixed effects measures across different hospital spells. Finally, we consider the evolution of pay (and its relationship with hospital performance) before and after a director's move. This is to capture whether and how pay was used to attract directors to work in the hospital, rather than in response to performance after being hired in the post.

6.1 Pay for performance across and within hospital spells

We start by examining whether CEOs and other board members were paid for performance during the sample period. Table 6 shows the correlation between the estimated director effects in pay (the α_i in Equation 3) and the estimated director effects in hospital production (the α_i in Equation 1). For all hospital production measures a larger director effect indicates better performance.[37] In column (1) we examine the correlations between directors' fixed effects in pay and performance. The correlation coefficients are generally *negative* – that is, better performing managers are on average paid *less* than others. For the sample of only CEOs in column (3), the results are generally statistically insignificant, with the exception of length of stay (which is negative) and MRSA rate (positive, but

[37] The estimation samples are essentially the same as in Table 3: if a director was observed for 4 years, they will appear in the sample 4 times with their pay director effect and their hospital production director effect. Thus, these regressions implicitly use frequency weights. For some directors we might not observe their pay or we might not observe the relevant hospital production measure, resulting in a missing director effect in either pay or the relevant hospital production measure. As a result, the sample sizes in Table 6 are slightly smaller than in Table 3.

significant only at the 10% level).

Table 6: Correlations between fixed effects in directors' pay and fixed effects in hospital production (larger fixed effect means better performance)

	All directors			Only CEOs		
	Director effects (1)	Hospital-by-director effects (2)	Obs.	Director effects (3)	Hospital-by-director effects (4)	Obs.
Surplus						
r(pay, surplus)	-0.07***	-0.21***	7,710	0.01	-0.35***	1,606
Waiting times × (-1)						
r(pay, waiting)	-0.003	-0.06***	7,543	0.01	-0.03	1,576
Day cases						
r(pay, day cases)	0.01	-0.11***	7,663	0.04	-0.02	1,597
Length of stay × (-1)						
r(pay, length)	-0.07***	0.26***	7,640	-0.09***	0.33***	1,584
MRSA rate × (-1)						
r(pay, MRSA)	-0.05***	-0.21***	6,799	0.05*	-0.31***	1,325
Job satisfaction						
r(pay, job satis.)	-0.02	-0.10***	6,297	0.05	-0.08***	1,195

The column "director effects" shows the correlation between the director effect in pay and the director effect in the production measure indicated in the row title. The column "hospital-by-director effects" shows the correlation between the hospital-by-director effects in pay and the hospital-by-director effects in the hospital production measure indicated in the row title. The director effects and hospital-by-director effects for waiting times, length of stay and MRSA rate have been multiplied by -1, so more is always better. The director effects for pay are from the two-way fixed effects model in Equation 3 and the director effects for the hospital production measures are from the two-way fixed effects model in Equation 1. The hospital-by-director effects for pay are the η_{ij} in Equation 5 and the hospital-by-director effects for the hospital production measures are the η_{ij} in Equation 4. *Significant at 10%, **significant at 5%, ***significant at 1%

Overall, these results show little and, if anything, negative correlations between long-term performance and pay for both all directors and the subset of CEOs. Thus, local boards do not appear to have used pay to reward those who were able to achieve better outcomes over the long term.

The absence of a relationship between pay and performance directors' fixed effects does not preclude the presence of this correlation within specific hospital spells. To examine this, columns (2) and (4) in Table 6 present the correlations between the estimated hospital-by-director effects in pay and the estimated hospital-by-director effects for the different hospital production measures.[38] The results show, both for CEOs and for all di-

[38]The hospital-by-director effects in pay are the η_{ij} in Equation 5 and the hospital-by-director effects

rectors, that directors' pay is *negatively* associated with five of the six hospital production measures (surplus, waiting times, day cases, MRSA rate and job satisfaction). Only for length of stay are the correlation coefficients positive. Thus, even within spells, it appears that CEOs – and all other board members – are paid less for better performance.[39]

6.2 Pay and performance before and after a move

While boards do not seem to have used pay to reward performance while directors were employed by the hospital, they might have used pay to attract talented directors to their organization. In this case, we would observe a change in pay and in hospital production around the time of arrival of a director.

To study this possibility, we examine how pay, and separately, hospital production vary just before and after the move of a director with an event study design. Essentially, we compare individuals who move in a given year with those who do not. Starting with pay, we estimate the following regression for all directors in our data set.

$$pay_{ijt} = \boldsymbol{X}'_{jt}\boldsymbol{\beta} + \gamma\, tenure_{ijt} + \boldsymbol{Z}'_{ijt}\boldsymbol{\delta} + \lambda_t + \psi_j + \sum_{m=-3}^{3} \kappa_m\, observe^m_{ijt} + \varepsilon_{ijt} \tag{7}$$

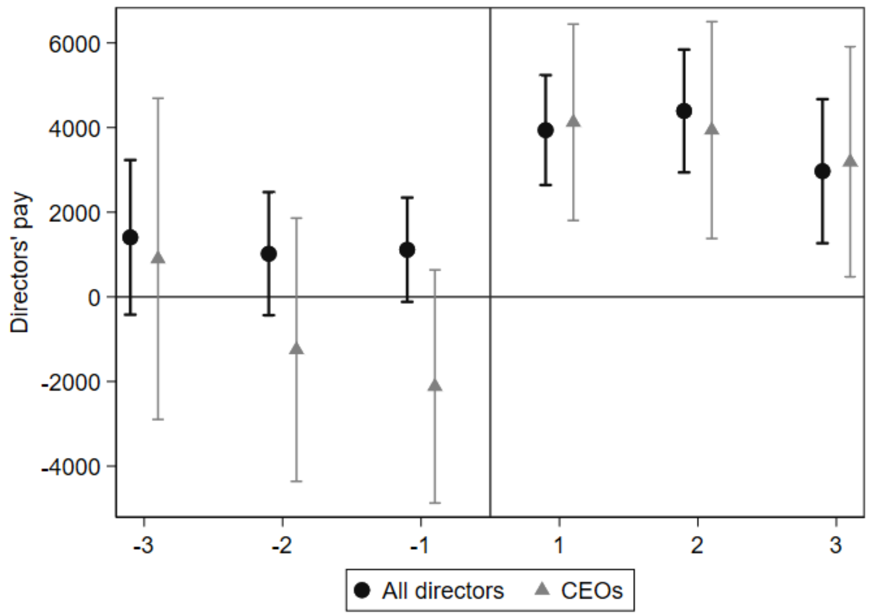
The control variables are the same as in Equation 3 but we replace the director effects a_i with a set of dummy variables $observe^m_{ijt}$. The variables $observe^m_{ijt}$ are six indicator variables that take the value one for directors that are observed at more than one hospital if the observation for director i in financial year t is their last observation at hospital j (m = -1), their second to last observation at hospital j (m = -2), their third to last observation at hospital j (m = -3), their first observation at hospital j (m = 1), their second observation at hospital j (m = 2) and their third observation at hospital j (m = 3), respectively. Otherwise these variables take the value zero. The coefficients on the indicator variables, κ_m, show the evolution of pay from three years before a move to three years after.[40] We report the coefficients in a event study plot for all directors. To obtain

for the hospital production measures are the η_{ij} in Equation 4. For all hospital production measures a larger hospital-by-director effect indicates better performance.

[39] Table W-8 in Web Appendix W-5 presents the correlations between the hospital-by-director effects in pay and the hospital-by-director effects in production separately for each of the different managerial titles, showing similar results across the different directors.

[40] Some directors appear to move to another hospital because their hospital merged with another hospital into a new entity. We exclude such moves when generating the indicator variables. For directors who move more than once the observations after they have moved could coincide with the "before" observations for their second or subsequent move. If moving does indeed increase directors' pay, then such coincident "before" observations could potentially result in a pay increase after a move wrongly being attributed to the "before" period. To avoid this problem we set $observe^{-3}_{ijt}$, $observe^{-2}_{ijt}$ and $observe^{-1}_{ijt}$ to

Figure 5: Pay of movers before and after moving



Note: Figure displays the coefficients κ_m in Equation 7 and their 95% confidence intervals for all directors. Coefficients for CEOs are obtained by estimating Equation 7 with interactions between the indicator variables $observe^m_{i(j,t)jt}$ and dummy variables indicating the board level position of director i at hospital j in financial year t. Results for the other board positions are in Figure W-3 in Web Appendix W-5.

separate estimates for the different director positions we also estimate Equation 7 with the indicator variables $observe^m_{ijt}$ interacted with the dummy variables indicating the board level position of director i at hospital j in financial year t (CEO, Finance Director, COO, Nursing Director, HR Director, Other Director).

Figure 5 shows results for all directors and for only CEOs. Results for the other board positions are in Figure W-3 in Web Appendix W-5. While there are no differences in pay between movers and non-movers before a move, upon moving pay jumps by around £4,000 and remains at this higher level for the subsequent two years. These increases in pay are larger for hospitals that were in greater need to fill vacancies (which we proxy with the definition of prestigious hospitals used in Section 5.4) and during periods with greater competition for managerial talent (which we capture by considering years of excess supply of directors due to exogenous hospital exits determined by the government). This is shown in Figure W-5 in Web Appendix W-5.

zero for the second or higher hospital at which we observe director i and we set $observe^1_{ijt}$, $observe^2_{ijt}$ and $observe^3_{ijt}$ to zero for the third or higher hospital at which we observe director i. As the number of directors who move more than once is small (the directors with 3+ spells in Figure 2a), including these higher-order moves in the control group is unlikely to affect our estimates.

Overall, this suggests that boards were deliberately using pay to more easily fill vacant director roles. Pay increases, however, were not correlated with detectable changes in hospital production. To see this, we estimate the following regression for our hospital production measures:

$$production_{i(j,t)jt} = \boldsymbol{X}'_{jt}\boldsymbol{\beta} + \lambda_t + \psi_j + \sum_{m=-3}^{3} \kappa_m \, observe^{m}_{i(j,t)jt} + \varepsilon_{i(j,t)jt} \tag{8}$$

The variables are the same as in Equation 1 but replacing the director effects a_i with the indicator variables $observe^{m}_{i(j,t)jt}$. As the function $i(j,t)$ maps hospital j to director i in year t, the coefficients on these indicators estimate the impact of a director on hospital production in the three years before they moved to another hospital and the director's impact on hospital production in the first three years at their next hospital. Figure 6 shows that there is no indication that a move led to an increase in performance for either CEOs or any of the the other top board members and one performance measure, staff satisfaction, falls in the first two years after the move.[41]

7 Conclusions

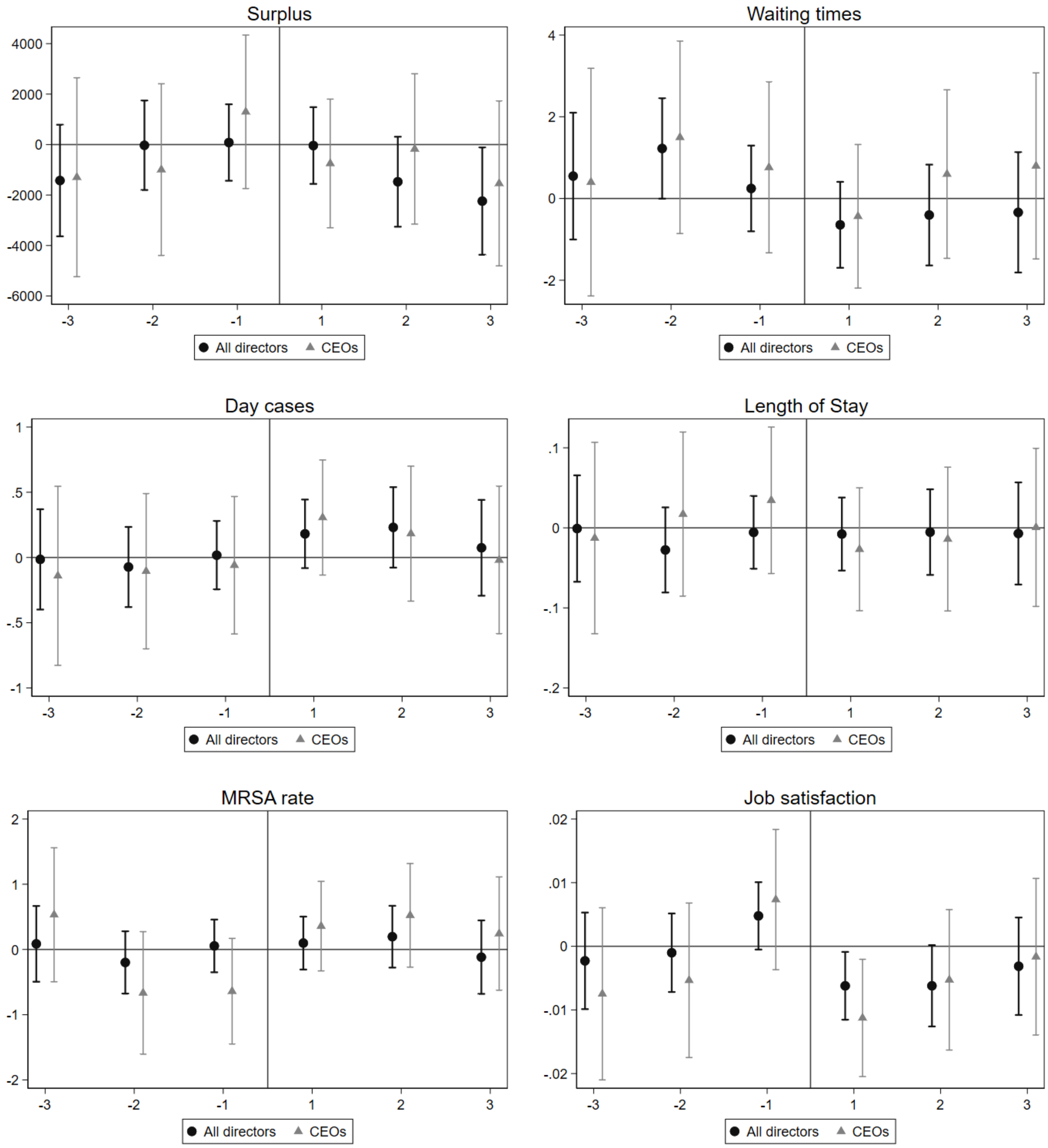
We study the impact of senior managers on the performance of public hospitals of the English National Health Service between 2000 and 2014. This setting is of interest given the various reforms that from the early 1990s attempted to transform these organizations from traditional bureaucracies to entities led by autonomous and accountable senior managers.

Despite the stated aims of the reforms, we find little evidence of managerial impact on hospital performance with respect to key targets, or indeed with respect to almost any of a wide range of measures of production explicitly and visibly monitored by the government. We also find that the lack of managerial impact is not due to the endogenous allocation of better performing directors to worse performing hospitals. However, we provide suggestive evidence that NHS directors may be in post for too short a time to have an effect. When examining managerial pay, we find that, while there is wide heterogeneity in pay across managers, differences in pay are generally uncorrelated with performance.

Our results are sobering in comparison to recent findings of managerial impacts in

[41] Figure 6 also suggests that movers did not have better performance than non-movers before the move. This evidence is corroborated by the analysis presented in Table W-9 in Web Appendix W-5, which shows no difference in the estimated fixed effects in hospital production of directors who have moved and those who have not (the α_i in Equation 1), as well as in a host of demographic and personal characteristics.

Figure 6: Hospital production of movers before and after moving



Notes: Figure displays the coefficients κ_m in Equation 8 and their 95% confidence intervals for all directors. Coefficients for CEOs only are obtained by re-estimating Equation 8 with interactions between the indicator variables $observe^m_{i(j,t)jt}$ and dummy variables indicating the board level position of director i at hospital j in financial year t. Results for the other board positions are in Figure W-4 in Web Appendix W-5.

other public sector organizations. A wide variety of factors may explain why our results diverge from this literature. A first possibility relates to the lack of supply of adequate managerial talent. While the reforms placed greater responsibilities on top managers under the premise that greater accountability and pay flexibility would incentivize directors to put the effort needed to improve hospital performance, they never explicitly targeted the need to attract a pool of individuals capable of managing large and complex organizations such as NHS hospitals (most of the managers in our study were promoted from within the NHS and often from clinical positions).[42] To the extent that there exists heterogeneity in managerial capabilities across directors, and that organizational performance depends on the correct match between hospitals' needs and managerial skills (e.g. Bandiera et al. (2020)), then the overall null impact of hospital directors may be a sign of a pervasive mismatch in the NHS managerial labor market. The limited supply of talent is consistent with two other findings in our data, namely a) short managerial tenures and frequent rotations; and b) pay premia connected to managerial moves, which is larger for hospitals in greater need to fill in vacant positions.

A second possibility is that the supply of talented managers willing to work in the NHS was adequate for the ambitions stated by the reforms, but that the reforms were unable to provide the right incentives for them to drive hospital performance. First, local boards did not appear to pay directors for performance. Second, the emphasis on local autonomy and hospital performance may have been thwarted by more mundane political pressures linked to the fact that the NHS is central in political discourse in the UK. Its importance means that politicians are very concerned about NHS performance, particularly negative performance, and are also keen to be seen to be doing something, which is generally manifest in a desire to implement new policies. The lack of persistent effects on production of CEOs and their fellow directors members is consistent with a scenario in which top managers simply chase political goals, rather than policies that might actually improve hospital performance (see, for example, qualitative studies in Powell & Davies (2016)). In this context, the rational response of a top director is not necessarily to improve the long-term performance of the hospital or even hit key targets but, instead, to simply minimize the amount of bad news that ends up on the Secretary of State's desk. This situation may explain why there is a CEO effect in remuneration that is not associated with observed hospital performance but is associated with receiving

[42]There may even be negative sorting due to the fact that, while managerial pay in the NHS was among the highest among public servants, it was still considerably lower than than of private sector managers and that pay for senior NHS managerial roles was widely – and critically– publicised in the British tabloid press.

a public honour.[43]

A third explanation is that the hope that the arrival of capable and well-paid senior managers could meaningfully impact the performance of large complex organizations, in which highly trained (and hard to monitor) individuals run separate but interconnected production processes, may just have been too ambitious to be true. This is because the performance of a hospital depends on the coordinated work of a large number of skilled workers, often with long tenures in their post, who may be hard to be influenced by the mere arrival of a (albeit capable) manager, especially if the expectation is that the manager would stay in place only for a short amount of time. This situation, of course, is not specific to public sector hospitals. But it may have more of an effect in hospitals, public or private, where there are many dimensions of performance (clinical, access, financial) that can be pursued and can in the short run conflict.[44] Coupled with the findings of Tsai et al. (2015) and Bloom, Propper, Seiler & Reenen (2015) that the management capabilities of middle managers in hospitals are systematically associated with better outcomes, our paper suggests that rather than seeking to rapidly change hospital performance through the appointment of a cadre of "superheads", strategies for improvement should also focus on nurturing and sustaining the skills of middle managers.

Finally, regardless of the underlying drivers of our results, they raise concerns about the plausibility of reforms that aspire to improve the performance of public sector organizations by mimicking the governance arrangements of the private sector and seeking to improve the performance of large and complex public sector organisations through the actions of senior managers and local boards.

[43] This results is only for CEOs and available from authors.

[44] A leading NHS manager recently argued that it takes five years for a CEO to make a difference but the average time in post is much shorter than that `https://www.hsj.co.uk/workforce/so-what-does-it-take-to-be-a-chief-executive-in-the-nhs/5091689.article`.

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Appendix A Variable Definitions and Sources

Tables A-1 and A-2 provide the data sources for all variables. The pay data are available only in bands of £5,000. We use the midpoint for each band as an approximation of the underlying continuous variable. For example, a basic salary reported as £120,000-£125,000 is recorded as £122,500 in our data set. The time-varying observable hospital level variables, $\boldsymbol{X}_{j(i,t)}$ are foundation trust status, year of merger, years since merger, beds, technology index and case mix variables.

Table A-1: Variable definitions and sources: Outcome variables

Variable	Definition	Source
Total pay	Total remuneration excluding redundancy payments, CPI adjusted (£)	IDS Incomes Data Services and remuneration reports in hospitals' annual reports
Surplus	Retained surplus/deficit (£000)	Trust Financial Returns
Waiting time	Mean time waited between decision to admit and actual admission (days)	Hospital Episode Statistics: Admitted Patient Care, Health and Social Care Information Centre, now NHS Digital
Day cases	Proportion of finished consultant episodes relating to day cases (%)	
Length of stay	Mean of spell duration, excluding day cases (days)	
MRSA rate	MRSA bacteraemia rate per 100,000 bed days	Public Health England
Staff job satisfaction	Scores from 1 to 5, 1 = dissatisfied, 5 = satisfied, mean	NHS Staff Survey

Technology Index The technology index can take any value between 0 and 1. It is the weighted average of 7 dummy variables indicating the availability of advanced technologies: a neonatal intensive care unit, a cardiology unit, magnetic resonance imaging, imaging using radio-isotopes, heart or lung transplants, open heart surgery and percutaneous coronary interventions. The weight for each of these technologies is the proportion of hospitals that do not possess that technology at the beginning of our sample in 2000/01. The resulting index value increases over the sample period as hospitals add technologies.

We use data from a wide range of administrative sources to generate the 7 dummy variables. A hospital is defined as having a neonatal intensive care unit if it has at least one bed in a neonatal intensive care unit, as reported in the beds data published annually in the Hospital Activity Statistics by NHS England. A hospital is defined as having a cardiology unit if according to annual Hospital Episode Statistics it delivered at least 10

Table A-2: Variable definitions and sources: Control variables

Variable	Definition	Source
Foundation Trust	Dummy variable taking value 1 once a hospital has achieved Foundation Trust status, 0 otherwise	Monitor, now NHS Improvement
Year of merger	Dummy variable taking value 1 in year hospital newly created through merger enters sample, 0 otherwise	Information on hospitals' websites and Statutory Instruments (www.legislation.gov.uk)
Years since merger	Variable taking value 1 in year after hospital newly created through merger enters sample, value 2 in following year and so on, 0 otherwise	
Acquisition	Dummy variable taking value 1 once hospital has been involved in merger that is more like acquisition, i.e. following merger hospital keeps its provider code while provider code of other hospital disappears from any records, 0 otherwise	
Beds	Average daily number of available beds	NHS England
Technology index	Details in text	Various sources
Patients aged 0 to 14	Finished Consultant Episodes (FCEs) involving patients aged 0 to 14/Total FCEs	Hospital Episode Statistics: Admitted Patient Care, Health and Social Care Information Centre, now NHS Digital
Patients aged 60 to 74	FCEs involving patients aged 60 to 74/Total FCEs	
Patients aged 75+	FCEs involving patients aged 75+/Total FCEs	
Male patients	FCEs involving male patients/Total FCEs	
Major teaching hospital	Dummy variable taking value 1 if hospital serves medical school as their major NHS partner, 0 otherwise	The Guardian Healthcare Professionals Network, Wikipedia and information on medical schools' websites
Minor teaching hospital	Dummy variable taking value 1 if hospital is not major teaching hospital but member of the Association of UK University Hospitals	Association of UK University Hospitals, now University Hospital Association
Specialist status	Hospital is specialist acute, children's or orthopaedic hospital	NHS Staff Survey
Hospital commission rating	Details in text	Various sources

finished consultant episodes in a cardiology speciality. We define a hospital as offering magnetic resonance imaging if according to the annual imaging data published as part of Hospital Activity Statistics by NHS England it delivered at least 100 examinations or tests using magnetic resonance imaging. Numbers in this data set tend to be around 1,000 to 30,000; so numbers smaller than 100 might be data entry errors. Similarly, we define a hospital as offering imaging using radio-isotopes if the annual imaging data reports at least 100 examinations or tests using radio-isotopes.

Further, we define a hospital as providing heart or lung transplants if the annual Hospital Episode Statistics report at least 2 transplant procedures (HRGs E01 and E02), as providing open heart surgery if the annual Hospital Episode Statistics report at least 10 open heart surgery procedures (HRGs E01 to E04) and as providing percutaneous coronary interventions (OPCS codes K49 and K75) if the annual Hospital Episode Statistics report at least 10 such interventions.

Once a dummy variable takes the value one, we set its value to one in all following years, to avoid fluctuations that are most likely caused by data entry errors rather than real changes.

Hospital Commission Rating We use ratings for the financial years 2002/03 to 2007/08. Ratings for the years 2002/02 to 2004/05 used stars, with three stars awarded to hospitals with the "highest levels of performance", two stars awarded to hospitals that are "performing well overall, but have not quite reached the same consistently high standards", one star awarded to hospitals "where there is some cause for concern regarding particular key targets" and zero stars awarded to hospitals "that have shown the poorest levels of performance against key targets" (Department of Health 2001). We classify zero stars and one star as a poor rating.

For the years 2005/06 to 2007/08 the Hospital Commission published ratings using a four-point scale of "excellent", "good", "fair" and "weak" (Healthcare Commission undated). Each hospital received two scores, one for quality of services and one for use of resources (Healthcare Commission undated). We use the score for quality of services and classify scores of "fair" and "weak" as a poor rating. Ideally, we want to use the hospital commission rating from the year before the CEO arrived. Because of data limitations we can use this definition only for the financial years 2003/04 to 2008/09. For the financial year 2002/03 we use the contemporanous rating, for 2009/10 the rating from two years before the CEO arrived and for 2010/11 the rating from three years before the CEO arrived.

Appendix B   Robustness of the AKM model

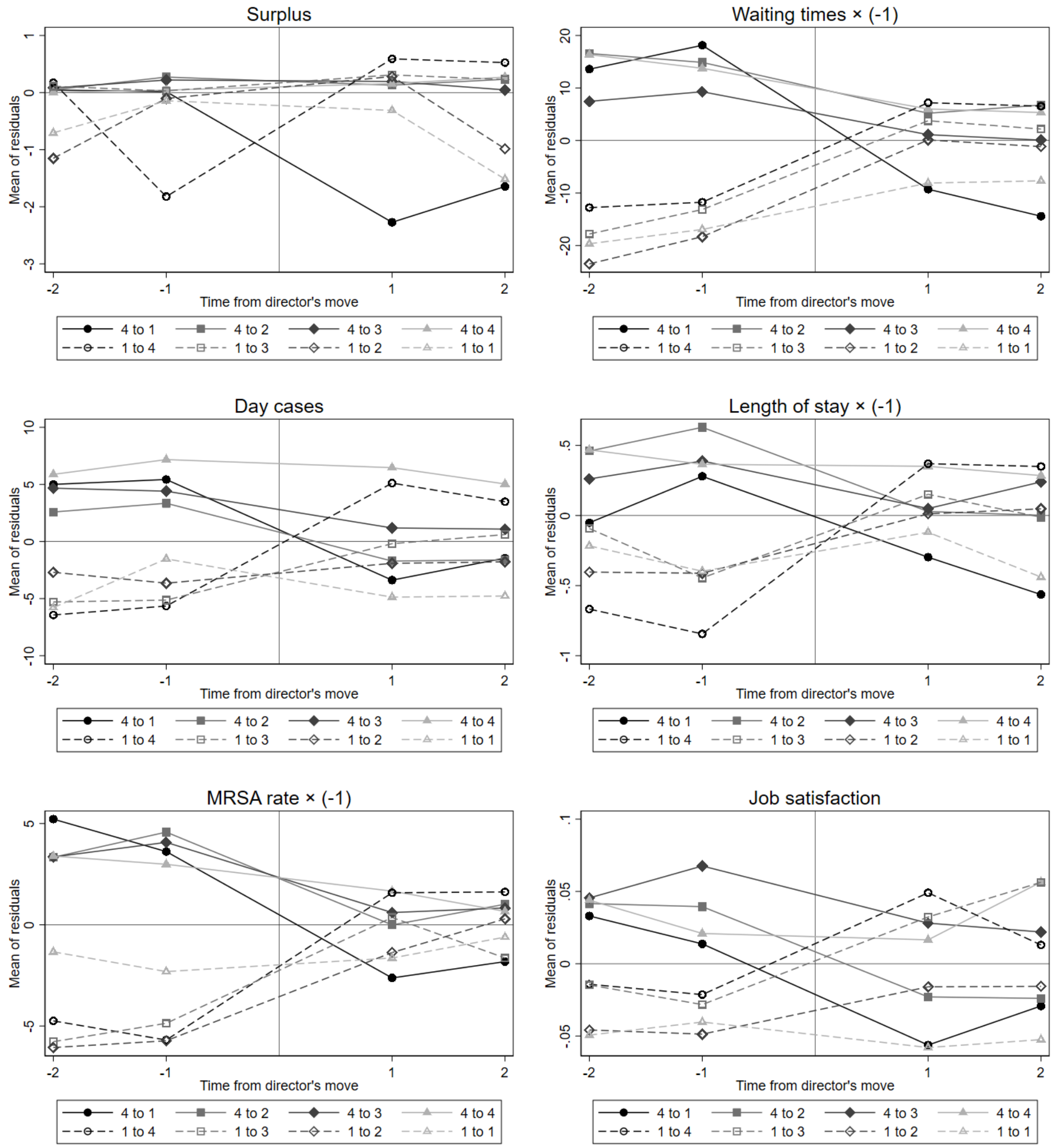
Sorting on match component We begin by conducting an event study around moves to determine whether these moves are systematically driven by sorting on the match-specific component, $\eta_{i(j,t)}$ in equation (2). For each hospital production variable, we classify moves based on the quartile of the fixed effect of the hospital the director moved away from and the quartile of the fixed effect of the hospital the director moved to. For moves from a quartile 4 hospital to a quartile 1, 2, 3 or 4 hospital and for moves from a quartile 1 hospital to a quartile 4, 3, 2 or 1 hospital, Figure B-1 plots the means of the residualised hospital production measure for the hospital that the director moved away from in the last two years before the move (periods -2 and -1) and for the hospital that the director moved to in the first two years after the move (periods 1 and 2). The hospital production measures are residualised by regressing them on year effects, foundation trust status, year of merger, years since merger, beds, technology index and case mix measures. Waiting times, length of stay and MRSA rate are multiplied by -1 before residualising, so more is always better.

If there was sorting on the match-specific component then changes in hospital production before and after a switch would not be symmetric (Card et al. 2013). Directors moving from a low to a high performing hospital would see a larger increase in the hospital production measure than the decrease experienced by directors moving from a high to a low performing hospital. The reason is that directors moving from a low to a high performing hospital would benefit from both higher average performance and an improved match effect, making the increase in the hospital production measure larger than it would be without sorting, while directors moving from a high to a low performing hospital would lose from the lower performance but benefit from an offsetting improved match effect, making the decrease in hospital production smaller than without sorting (Best et al. 2023).

Figure B-1 shows that for all of the hospital production measures the gain experienced by directors moving from a quartile 1 to a quartile 4 hospital is similar to the loss experienced by directors moving from a quartile 4 to a quartile 1 hospital. Similarly, the gains experienced by directors making the less extreme moves from a quartile 4 to quartile 2 or quartile 3 hospital are similar to the losses experienced by directors moving from a quartile 1 to a quartile 3 or a quartile 2 hospital. Furthermore, there is very limited change in the residualised hospital production measures for directors moving between hospitals in the same quartile (1 to 1 and 4 to 4).

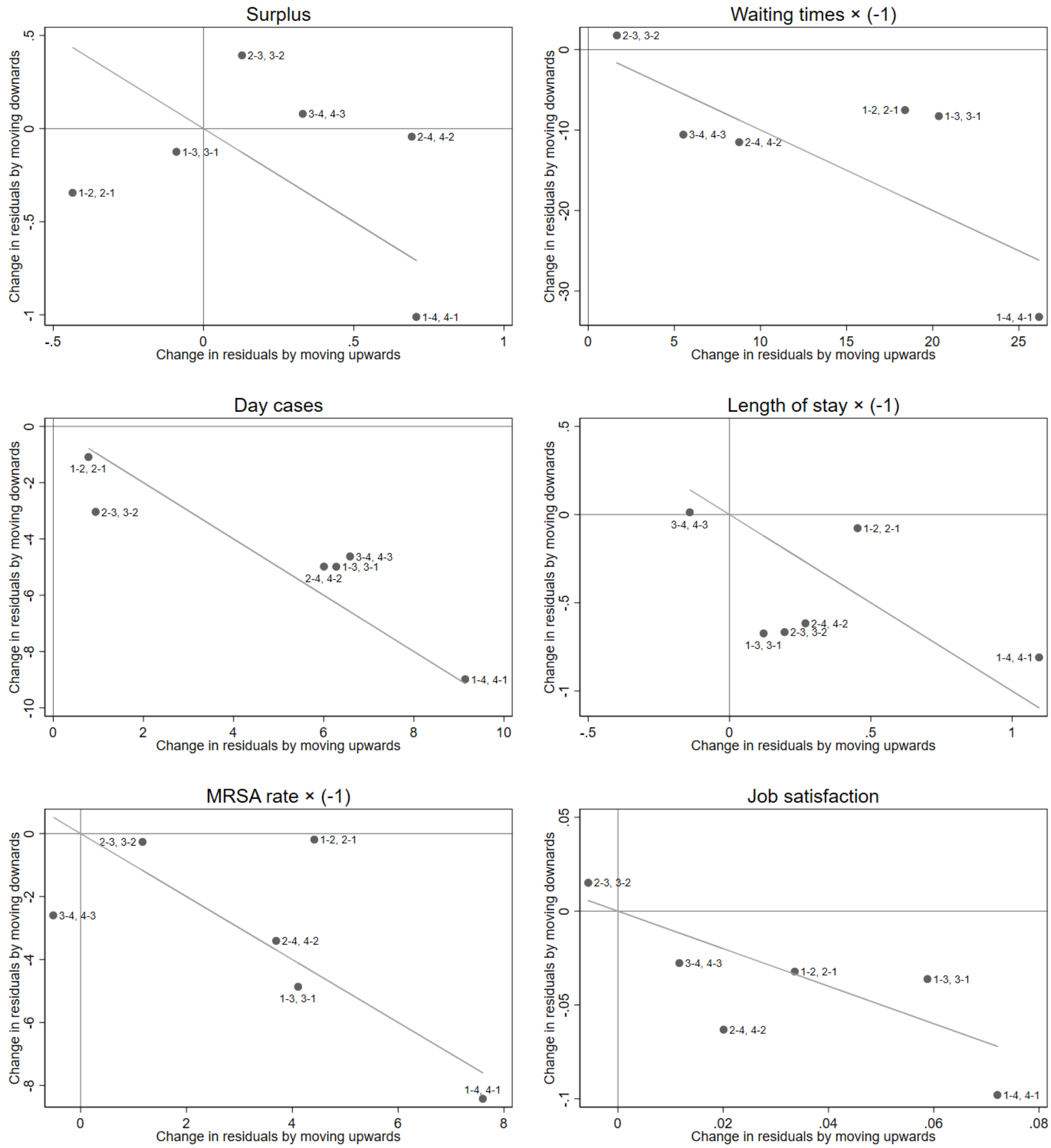
Figure B-2 presents the gains and the losses for all moves between different quartiles

Figure B-1: Means of residualised hospital production measures for director moves classified by hospital fixed effects for origin and destination hospitals



Notes: Figure shows means of the residualised hospital production measures for directors who changed hospital. Each director spell is classified into quartiles based on the estimated hospital fixed effects for the relevant hospital production measure from Equation 1 presented in Table 3. Hospital production measures are residualised by regressing them on year effects, foundation trust status, year of merger, years since merger, beds, technology index and case mix measures. Waiting times, length of stay and MRSA rate are multiplied by -1 before residualising, so more is always better. The means for time periods -2 and 2 tend to be based on fewer observations than the means for time periods -1 and 1 as not all movers were observed for more than one year before and after their move.

Figure B-2: Means of change in residualised hospital production measures for director moves from lower- to higher-performing hospitals versus means of change for moves in the opposite direction



Notes: Figure shows means of the difference between the mean of the residualised hospital production measure at the hospital a director moved to in the first two years after the move and the mean of the residualised hospital production measure at the hospital a director moved from in the last two years before the move (i.e. the change in the two-year mean of the residualised hospital production measure following the move) for moves from a lower quartile hospital to a higher quartile hospital on the x-axis and the opposite moves on the y-axis. See notes for Figure B-1 for details on classification of moves and residualising hospital production measures. Only directors observed for two years before and two years after their move are included in the calculations.

for each of the hospital production measures. On the x-axis are the gains for moves from a lower quartile hospital to a higher quartile hospital and on the y-axis are the losses for the opposite moves. For example, the point "2-4, 4-2" in the day cases plot shows that moves from a quartile 2 to a quartile 4 hospital improve residualised day cases by around 6 whereas moves from a quartile 4 to a quartile 2 hospital reduce residualised day cases by around 5. The solid line represents the 45-degree line, indicating perfect symmetry. If there is no sorting on the match-specific component, the changes in the residualised hospital production measures should be similar but opposite in sign.

Most of the points are to the right of the zero line on the x-axis, suggesting that moves from a lower quartile to a higher quartile hospital result in an increase in the residualised hospital production measure. Moves in the opposite direction seem to result in a loss in hospital production as most of the points are below the zero line on the y-axis. Most of these gains and losses appear symmetric, being close to the 45 degree line. For nearly all of the points the individual 95% confidence intervals or the "confidence boxes" created by the combination of confidence intervals overlap with the 45 degree line. Plots with confidence intervals are in Figure W-6 in Web Appendix W-5. Thus, there is no evidence of sorting on the match-specific component.

We undertake a further test proposed by Card et al. (2013) and compare the fit of the two-way fixed effects model in equation (1) to the fit of the fully saturated model in equation (4). If match effects were important the fully saturated model with a hospital-by-director effect for each director spell should fit much better than two-way fixed effects model with separate hospital and director effects. Table B-3 shows that the fully saturated model increases the adjusted R^2 by between 0.6% and 2.9%. The improvement in fit is very small, suggesting that match effects are not important, thus limiting the scope for sorting on the match-specific component.

Sorting on unit root component To establish whether moves are systematically driven by sorting on the unit root component, ξ_{jt} in equation (2), we follow Card et al. (2013) and assess the trends prior to a director move in Figure B-1. Identification in the AKM model requires that there is no drift in hospital production which is correlated with a change in director. Figure B-1 shows no systematic trends in the two years before a move. For surplus and length of stay there appear to be some small changes in the periods before a move. However, these changes are small and not systematically related to whether a director moves to a high-production or a low-production hospital. Confidence intervals are not shown but the differences in residualised hospital production between period -2 and period -1 are not statistically significant for any of the hospital production measures.

Table B-3: Explanatory power of two-way fixed effect model (separate hospital and director effects) and fully saturated model (hospital-by-director effects)

	Surplus	Waiting times	Day cases	Length of stay	MRSA rate	Job satis-faction	Direc-tors'-pay
Hospital and director effects							
Adjusted R^2	0.172	0.871	0.893	0.851	0.805	0.751	0.903
Hospital-by-director effects							
Adjusted R^2	0.177	0.887	0.903	0.856	0.810	0.756	0.924
Observations	7,736	7,569	7,689	7,666	6,868	6,353	7,710

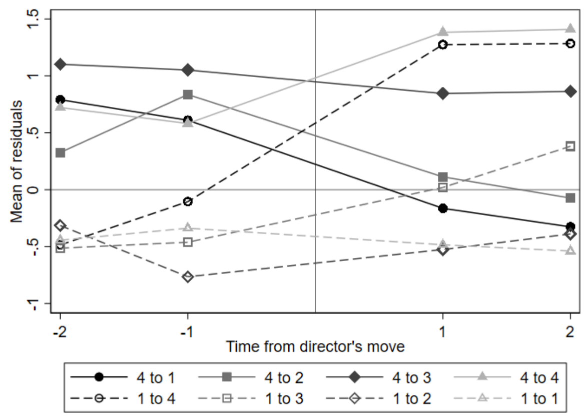
The "hospital and director effects" results are from the model in equation (1) or equation (3). The "hospital-by-director" effects results are from the model in equation (4) or equation (5).

Thus, there is no evidence for sorting on the unit root component.

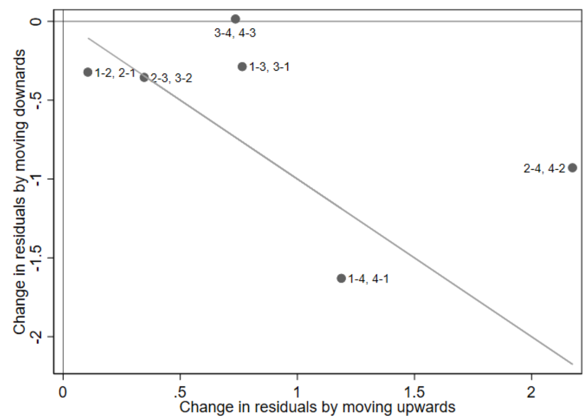
Sorting on match component and unit root component in directors' pay We repeat the above tests of the identification assumptions of the AKM model for directors' pay. Figure B-3a shows that there is no change in residualised directors' pay for directors moving between hospitals with hospital fixed effects in directors' pay in quartile 1. There appears to be a small increase in pay for moves between hospitals in quartile 4, suggesting a mobility premium for movers, which is in line with our findings in Section 6.2. For moves between hospitals in different quartiles, Figures B-3a and B-3b suggest that the gains in directors' pay for moves from low- to high-paying hospitals are similar to the losses in pay for moves from high to low paying hospitals. There are no systematic trends in directors' pay in the two years before a move and any changes are small and not systematically related to whether a director moves to a high-paying or low-paying hospital. Thus, there is no evidence of sorting on the match component or the unit root component.

The last column of Table B-3 shows that the fit of the fully saturated model for directors' pay in equation (5) is only slightly better than the fit of the two-way fixed effects model in equation (3), with an increase in the adjusted R^2 by 2.3%, thus limiting the scope for sorting on the match component.

Figure B-3: Event study assessing the symmetry of the gains in directors' pay for moves from low- to high-paying hospitals and the losses in directors' pay for moves in the opposite direction



(a) Event study plot



(b) Symmetry plot

Notes: Plot (a) shows means of residualised directors' pay for directors who change hospital. Each director spell is classified into quartiles based on the estimated hospital fixed effects in directors' pay from equation (3) presented in Table 3. The means for time periods -2 and 2 tend to be based on fewer observations than the means for time periods -1 and 1 as not all movers were observed for more than one year before and after their move. Plot (b) shows means of the difference between the mean of directors' residualised pay in the last two years before a move and the mean of directors' residualised pay in the first two years after a move (i.e. the change in the two-year mean of residualised directors' pay following the move) for moves from a hospital with a lower quartile hospital fixed effect in directors' pay to a hospital with a higher quartile hospital fixed effect in directors' pay on the x-axis and the opposite moves on the y-axis. Only directors observed for two years before and two years after their move are included in the calculations. Directors' pay is residualised by regressing on tenure, indicators of board level position, year effects, foundation trust status, year of merger, years since merger, beds, technology index and case mix measures.

Web Appendix: For Online Publication

W-1 Director turnover

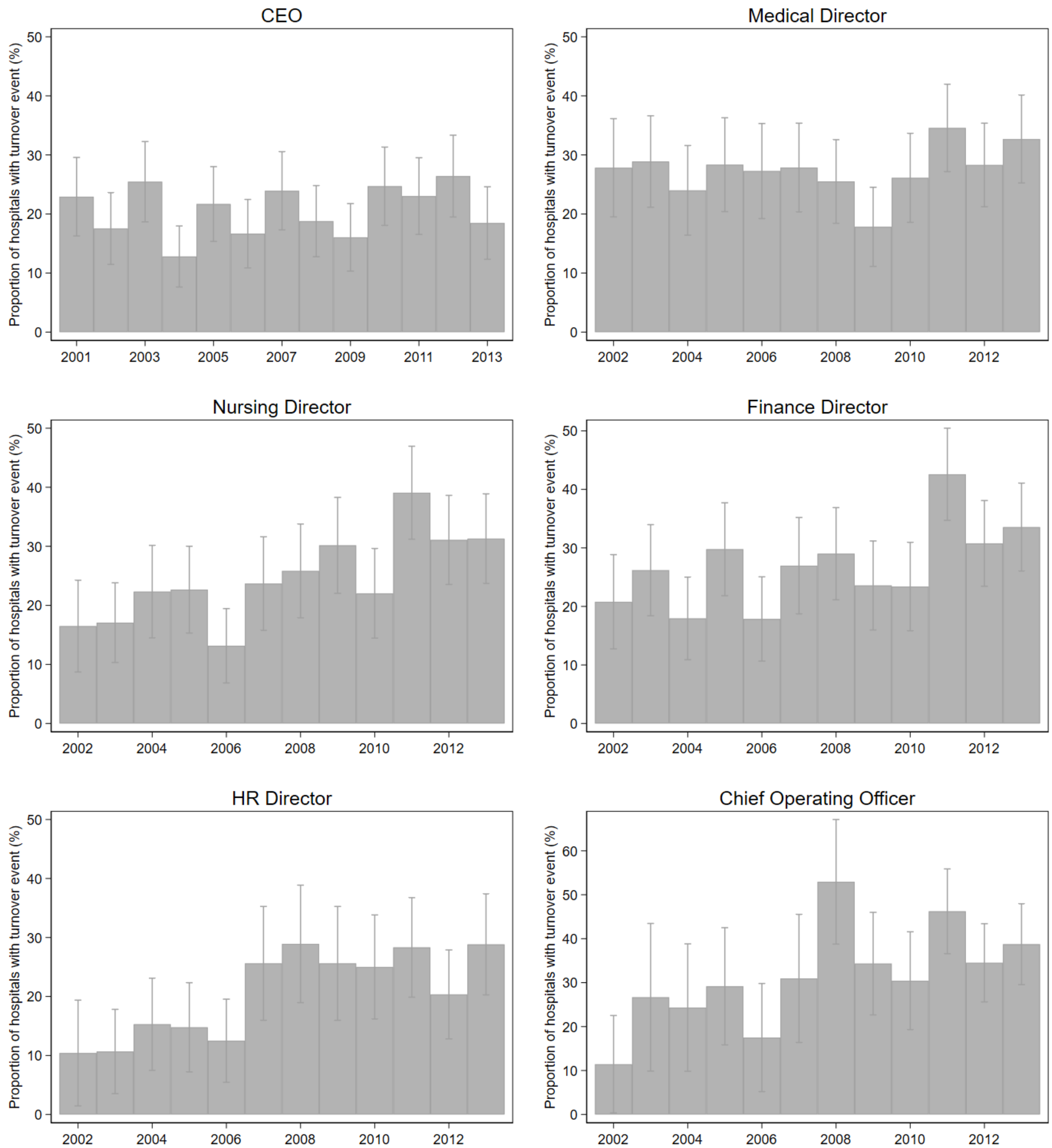
Figure W-1 shows for each of the six core board positions the annual proportion of hospitals with a director turnover event. The proportions are essentially the annual means of a dummy variable indicating a turnover event. The ranges indicate the 95% confidence intervals around each of the annual means, showing more dispersion for the Chief Operating Officer position due to very few boards including this position in the early years of our sample. From 2008 onward the number of boards that include a Chief Operating Officer starts to increase and by 2011 the majority of boards include the position. The wider confidence intervals for HR Directors are driven by a similar issue, although the number of boards that include the position starts to increase from 2003 onward, soon reaching around 50% of boards and the majority of boards by 2011. The more precisely estimated proportions for the positions of CEO, Medical Director, Nursing Director and Finance Director reflect the more consistent presence of these positions in our data.

W-2 Comparison of NHS hospital director pay and executive pay at UK public service providers

To examine how hospital managers' pay compares to executive pay at UK public service providers, we present pay data from the Quarterly Labour Force Survey, the largest household study in the UK, from April 2000 to March 2017. This survey provides the official measures of employment and unemployment. The survey includes respondents' gross weekly pay and industry classification (SIC), occupation classification and whether they work in the public or private sector. We focus on respondents whose occupation classification is "Directors and Chief Executives of Major Organisations". We convert weekly gross pay to annual gross pay and adjust for inflation using the consumer price index (base year = 2000). To deal with outliers and limited cell sizes for some industry-sector combinations, we windsorize the pay data at the 5% level, with the top 5% of data replaced with the 95^{th} percentile and the bottom 5% replaced with the 5^{th} percentile.

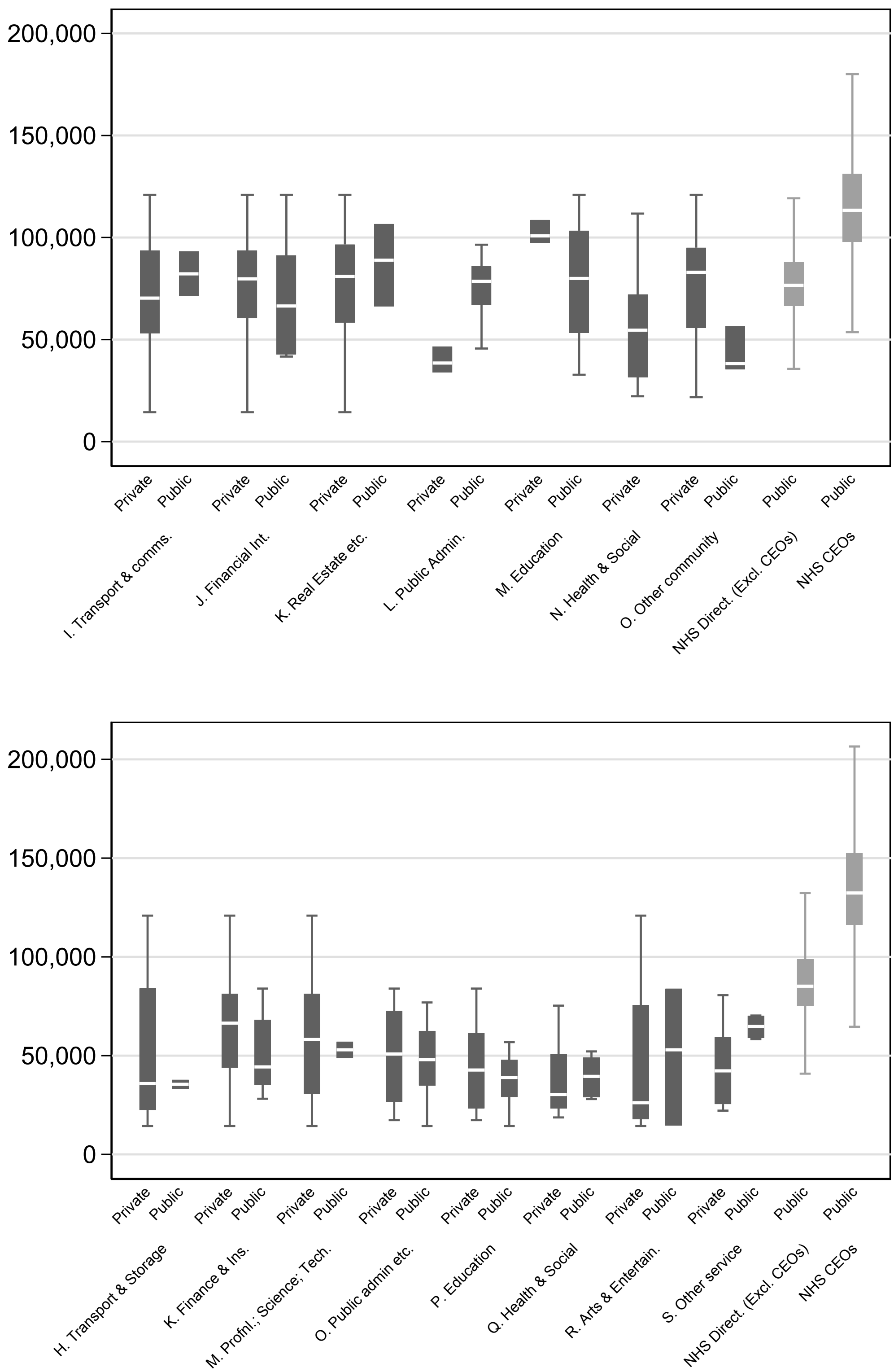
Figure W-2 presents pay split by industry and public and private sector. As the industry classification was changed substantially in 2009, we present separate graphs for 2000-2008 and 2009-2017. In both periods NHS hospital CEOs and non-CEO directors were well paid relative to top managers at a wide range of organizations in both the public and private sector. On average NHS directors received the largest pay packages. A comparison between the upper and lower graph suggests the gap between the pay of NHS

Figure W-1: Annual proportion of hospitals with director turnover event for each of the core board positions



Notes: Ranges indicate 95% confidence intervals around the annual means of a dummy variable indicating a turnover event.

Figure W-2: Annual gross pay for "Directors and Chief Executives of Major Organisations" and basic pay for NHS CEOs and non-CEO directors in 2000-2008 (top) and 2009-2017 (bottom)



Notes: All pay values adjusted for inflation using Consumer Price Index (base year = 2000). Non-NHS pay data from Quarterly Labour Force Survey, winsorized at the 5% level.

directors and that of directors in other organizations grew rather than diminished over the period. These comparisons do not take into account pension entitlements which are also more generous in the NHS than in other public and private sector organizations. Thus, while NHS hospitals were unable to provide pay comparable to that offered in similar large and complex private sector companies, over the time period we consider NHS directors were among the most highly rewarded executives in public sector organizations.

Differences in industry classification between top and bottom panel of Figure W-2 Data for 2000 to 2008 use the "UK Standard Industrial Classification of Economic Activites - SIC 92" while data for 2009 to 2017 use the the "UK Standard Industrial Classification of Economic Activities - SIC 2007". In SIC 92 the section "K - Real estate, renting and business activities" includes "73.10 Research and experimental development on natural sciences and engineering" and "73.20 Research and experimental development on social sciences and humanities". In SIC 2007 these activities have been subsumed into the new section "M - Professional, scientific and technical activities". The SIC 92 section "I - Transport, storage and communication" includes "60.1 Transport via railways", "60.21 Other scheduled passenger land transport" and "64.11 National post activities". These industries are comparable to the SIC 2007 section "H - Transportation and storage", which includes "49.10 Passenger rail transport interurban", "49.31 Urban and suburban passenger land transport" and "53.10 Postal activities under universal service obligation".

The SIC 92 section "J - Financial intermediation" includes "65.11 Central banking" and "66.02 Pension funding". Similarly, the SIC 2007 section "K - Financial and Insurance Activities" includes "64.11 Central banking" and "65.30 Pension funding". The SIC 92 section "L - Public administration and defence, compulsory social security" includes "75.24 Public security, land and order activities", which is comparable to the SIC 2007 section "O - Public administration and defence, compulsory social security", which includes "84.23 Justice and judicial activities" and "84.24 Public order and safety activities". The SIC 92 section "O - Other community, social and personal service activities" includes "92 Recreational, cultural and sporting activities". In SIC 2007 these activities have been subsumed into the new section section "R - Arts, entertainment and recreation".

W-3 Details on the leave-one-out estimator for the covariance between the hospital and director effects

We use the leave-one-out estimator proposed by Kline et al. (2020) to obtain unbiased estimates of the covariance between the hospital and director effects. The leave-one-out estimator is based on the leave-one-out estimate of the i-th error variance $\hat{\sigma}_i^2 = pay_{ijt}(pay_{ijt} - \boldsymbol{X}'_{jt}\hat{\boldsymbol{\beta}}_{-ij} - \hat{\gamma}_{-ij}tenure_{ijt} - \boldsymbol{Z}'_{ijt}\hat{\boldsymbol{\delta}}_{-ij} - \hat{\lambda}_{t(-ij)} - \hat{\alpha}_{i(-ij)} + \hat{\psi}_{j(-ij)})$ where $\hat{\beta}_{-ij}$, $\hat{\gamma}_{-ij}$, $\hat{\boldsymbol{\delta}}_{-ij}$, $\hat{\lambda}_{t(-ij)}$, $\hat{\alpha}_{i(-ij)}$ and $\hat{\psi}_{j(-ij)}$ are the OLS estimates of the parameters in Equation 3 if director-hospital combination ij is left out. The leave-one-out estimate $\hat{\sigma}_i^2$ is then "plugged in" to the covariance matrix to obtain a heteroskedasticity-unbiased estimate of the sampling variability of the $\hat{\alpha}_i$ and the $\hat{\psi}_j$, which in turn can be used to bias-correct the estimate of the covariance between the hospital and director effects. The same logic applies to Equation 1 for the hospital production measures.

We use the MATLAB package provided by Kline et al. (2020), which deals with the problem of estimating director effects for directors that never leave a particular hospital and therefore are not leave-director-hospital-combination-out estimable by leaving only a single observation out for these directors. If our dataset contains only a single observation for a director, this director drops out of the leave-one-out connected set.

W-4 Descriptive statistics for connected sets

Table W-1: Descriptive statistics of the standard connected set and the leave-one-out connected set nested within the standard connected set for each of the hospital production measures and for directors' pay

	Standard connected set				Leave-one-out connected set nested within standard connected set			
	Obs.	Hospitals	Directors	Mean of outcome variable	Obs.	Hospitals	Directors	Mean of outcome variable
Surplus								
Connected set	8,790	200	2,115	-2,333	7,736	174	1,532	-2,420
Outside CS	163	17	47	1,060	1,054	178	583	-1,693
Waiting times								
Connected set	8,628	200	2,103	67.0	7,569	174	1,515	66.7
Outside CS	163	17	47	59.5	1,059	178	588	69.1
Day cases								
Connected set	8,739	200	2,115	31.1	7,689	174	1,530	30.7
Outside CS	163	17	47	31.7	1,050	178	585	34.3
Length of stay								
Connected set	8,751	200	2,113	4.96	7,666	173	1,521	4.86
Outside CS	163	17	47	6.20	1,085	178	592	5.66
MRSA rate								
Connected set	8,069	162	1,972	9.79	6,868	144	1,388	9.90
Outside CS	221	4	48	5.53	1,201	151	584	9.17
Job satisfaction								
Connected set	7,511	173	1,900	3.47	6,353	156	1,335	3.47
Outside CS	185	4	45	3.50	1,158	154	565	3.49
Total pay								
Connected set	8,760	196	2,111	92,353	7,710	173	1,528	92,300
Outside CS	162	17	47	88,039	1,050	176	583	92,739

CS = connected set. The leave-one-out connected set is the largest connected set of hospitals that remains connected after any director-hospital combination is removed, see Kline et al. (2020) for details. The number of hospitals inside the leave-one-out connected set and the number of hospitals outside the leave-one-out connected set sum to more than the total number of hospitals in our data set because directors with only one observation drop out of the connected set when applying the leave-one-out estimator as their director fixed effect cannot be estimated when their one observation is left out. The hospitals at which these directors are observed are added to the count of hospitals outside the leave-one-out connected set even though the same hospitals might be inside the leave-one-out connected set through other directors with more than one observation.

Table W-2: Descriptive statistics of movers and non-movers in the standard connected set and the leave-one-out connected set nested within the standard connected set for each of the hospital production measures

	Movers			Non-movers		
	Obs.	Persons	Mean of outcome variable	Obs.	Persons	Mean of outcome variable
Surplus						
Standard connected set	3,051	482	-3,320	5,739	1,633	-1,807
Leave-one-out CS	2,875	455	-3,424	4,861	1,077	-1,826
Waiting times						
Standard connected set	2,975	474	67.0	5,653	1,629	66.9
Leave-one-out CS	2,799	447	66.6	4,770	1,068	66.7
Day cases						
Standard connected set	3,038	482	30.7	5,701	1,633	31.3
Leave-one-out CS	2,862	455	30.5	4,827	1,075	30.8
Length of stay						
Standard connected set	3,037	481	4.87	5,714	1,632	5.01
Leave-one-out CS	2,855	453	4.82	4,811	1,068	4.89
MRSA rate						
Standard connected set	2,428	385	9.95	5,641	1,587	9.72
Leave-one-out CS	2,315	367	9.95	4,553	1,021	9.87
Job satisfaction						
Standard connected set	2,290	391	3.47	5,221	1,509	3.48
Leave-one-out CS	2,197	374	3.47	4,156	961	3.47

CS = connected set. The leave-one-out connected set is the largest connected set of hospitals that remains connected after any director-hospital combination is removed, see Kline et al. (2020) for details.

Table W-3: Descriptive statistics of movers and non-movers in the standard connected set and the leave-one-out connected set nested within the standard connected set for directors' pay

	Movers			Non-movers		
	Obs.	Persons	Mean of outcome variable	Obs.	Persons	Mean of outcome variable
Total pay						
Standard connected set	3,031	479	100,565	5,729	1,632	88,008
Leave-one-out CS	2,860	453	100,156	4,850	1,075	87,668
By board position:						
CEO						
Standard connect. set	948	171	129,596	903	226	122,695
Leave-one-out CS	865	160	129,446	741	157	121,964
Finance Director						
Standard connect. set	534	93	96,682	945	282	92,909
Leave-one-out CS	519	89	97,059	790	191	92,448
Chief Operating Officer						
Standard connect. set	298	103	93,132	481	188	83,392
Leave-one-out CS	285	99	92,537	399	125	83,440
Nursing Director						
Standard connect. set	530	95	82,790	914	273	79,059
Leave-one-out CS	497	91	82,406	773	182	79,646
HR Director						
Standard connect. set	298	59	78,738	746	218	76,293
Leave-one-out CS	283	56	78,920	653	155	76,659
Other						
Standard connect. set	423	134	83,287	1,740	589	78,345
Leave-one-out CS	411	129	83,792	1,494	397	78,222

CS = connected set. The leave-one-out connected set is the largest connected set of hospitals that remains connected after any director-hospital combination is removed, see Kline et al. (2020) for details. The number of persons for each of the positions does not sum to the overall number of persons because some directors are observed in more than one position.

W-5 Additional results

Additional portability results Table W-4 presents results for the portability regressions separately for each of the board positions. We see that the positive correlations for waiting times are driven by COOs and Finance Directors and the portability for MRSA rates is driven by Finance Directors and Nursing Directors. Looking at the correlation coefficients, portability in pay is similar for all board members.

Table W-5 presents results for the portability regressions for our preferred sample that excludes moves due to a merger in Column 1, the alternative sample that includes all moves in Column 2 and for the sub-sample of moves that are due to a merger in Column 3. When we include moves due to a merger there is some suggestion of portability. However, repeating the analysis for the sub-sample of moves due to a merger shows that any positive associations are driven by the moves due to a merger, which are very different from moves between two completely different hospitals as the director's previous hospital makes up a large part of the new entity.

Additional tenure results Table W-6 presents results for the tenure regressions separately for each of the board positions. We see that the positive association between total time in post and waiting times is driven by Finance Directors and other directors and that the positive effect of total time in post on job satisfaction applies to all board positions with the exception of HR directors.

Table W-7 presents results for the tenure regressions for two different specifications. Model 1 regresses the hospital-by-director effect on total time in post in years; Model 2 uses three dummy variables to measure total time in post: 3 to 4 years, 5 to 8 years and 9 and more years with 1 to 2 years being the omitted category. We have standardized the hospital-by-director effects to allow comparisons between the different production measures and directors' pay. The hospital-by-director effects for waiting times, length of stay and MRSA rate have been multiplied by -1, so for all hospital production measures a larger hospital-by-director effect means better hospital production.

We see a strong statistically significant positive relationship between total time in post and the hospital-by-director effects for staff job satisfaction. The estimates from Model 2 suggest that compared to a director who stays for only one or two years the hospital-by-director effect for a director who stays for three or four years increases by 1/5 of a standard deviation. For a director who stays for 9 years or longer the increase is nearly half of a standard deviation. For surplus and waiting times there is also a statistically significant positive relationship, with the effect size around half of the effect size for job satisfaction.

Table W-4: Portability regressions estimating the association between the two or more hospital-by-director effects available for movers for each of the board positions

	All directors	CEOs	Finance Directors	COOs	Nursing Directors	HR Directors	Other directors
Surplus							
Regress. coeff.	-0.002	0.052	0.16	0.64	0.12	-0.15	-0.39
	(0.09)	(0.13)	(0.22)	(0.48)	(0.24)	(0.15)	(0.35)
Correl. coeff.	-0.001	0.030	0.074	0.17	0.056	-0.15	-0.15
Obs.	532	175	101	64	82	49	61
Waiting times							
Regress. coeff.	0.046*	-0.026	0.096*	0.21***	0.066	0.049	0.044
	(0.026)	(0.047)	(0.051)	(0.078)	(0.075)	(0.093)	(0.071)
Correl. coeff.	0.08	-0.04	0.19	0.33	0.10	0.077	0.08
Obs.	523	174	99	62	81	48	59
Day cases							
Regress. coeff.	0.024	-0.021	-0.025	-0.17	0.49***	-0.10	-0.030
	(0.042)	(0.075)	(0.058)	(0.20)	(0.11)	(0.19)	(0.11)
Correl. coeff.	0.025	-0.021	-0.043	-0.10	0.44	-0.078	-0.036
Obs.	532	175	101	64	82	49	61
Length of stay							
Regress. coeff.	0.050	-0.007	0.17***	0.032	0.044	-0.14	0.30**
	(0.032)	(0.058)	(0.054)	(0.14)	(0.076)	(0.11)	(0.11)
Correl. coeff.	0.067	-0.009	0.30	0.028	0.065	-0.18	0.32
Obs.	529	173	101	63	82	49	61
MRSA rate							
Regress. coeff.	0.091***	0.026	0.14**	0.086	0.15**	0.13	0.10
	(0.030)	(0.059)	(0.059)	(0.11)	(0.070)	(0.079)	(0.087)
Correl. coeff.	0.14	0.037	0.26	0.11	0.25	0.26	0.17
Obs.	449	146	85	56	69	40	53
Job satisfaction							
Regress. coeff.	0.057	0.112	0.032	0.040	0.20	0.28	-0.22*
	(0.049)	(0.087)	(0.097)	(0.13)	(0.17)	(0.17)	(0.12)
Correl. coeff.	0.057	0.11	0.038	0.039	0.14	0.25	-0.26
Obs.	426	131	79	61	67	42	46
Directors' pay							
Regress. coeff.	0.72***	0.73***	0.48***	0.56***	0.58***	0.33**	0.60***
	(0.052)	(0.088)	(0.15)	(0.14)	(0.14)	(0.12)	(0.21)
Correl. coeff.	0.52	0.53	0.31	0.45	0.41	0.37	0.36
Obs.	528	174	100	63	82	48	61

Standard errors in (parentheses). The hospital-by-director effects for the hospital production measures are the η_{ij} in Equation 4 and the hospital-by-director effects for pay are the η_{ij} in Equation 5. *Significant at 10%, **significant at 5%, ***significant at 1%

Table W-5: Portability regressions estimating the association between the two or more hospital-by-director effects for movers for different samples

	Omit moves due to merger (preferred sample)	All moves (alternative sample)	Moves due to merger (sub-sample)
Surplus			
Regress. coeff.	-0.002	0.31***	0.70***
	(0.089)	(0.071)	(0.097)
Correl. coeff.	-0.001	0.18	0.78
Obs.	532	567	35
Waiting times			
Regress. coeff.	0.046*	0.058**	0.63***
	(0.026)	(0.026)	(0.11)
Correl. coeff.	0.08	0.09	0.72
Obs.	523	558	35
Day cases			
Regress. coeff.	0.024	0.027	0.22
	(0.042)	(0.041)	(0.14)
Correl. coeff.	0.025	0.028	0.27
Obs.	532	567	35
Length of stay			
Regress. coeff.	0.050	0.051	-0.19
	(0.032)	(0.033)	(0.23)
Correl. coeff.	0.067	0.066	-0.14
Obs.	529	564	35
MRSA rate			
Regress. coeff.	0.091***	0.086***	-
	(0.030)	(0.030)	-
Correl. coeff.	0.14	0.13	-
Obs.	449	450	1
Job satisfaction			
Regress. coeff.	0.057	0.062	1.10***
	(0.049)	(0.048)	(0.29)
Correl. coeff.	0.057	0.061	0.74
Obs.	426	440	14
Directors' pay			
Regress. coeff.	0.72***	0.74***	0.90***
	(0.052)	(0.048)	(0.097)
Correl. coeff.	0.52	0.54	0.85
Obs.	528	563	35

Standard errors in (parentheses). The hospital-by-director effects for pay are from the fully saturated model in Equation 5 and the hospital-by-director effects for the hospital production measures are from the fully saturated model in Equation 4. *Significant at 10%, **significant at 5%, ***significant at 1%

Table W-6: Association between directors' total time in post at a hospital and the corresponding hospital-by-director effect for each of the board positions

	All directors	CEOs	Finance Directors	COOs	Nursing Directors	HR Directors	Other directors
Surplus							
Total time in	0.026***	0.029*	0.039**	0.067	-0.000	0.004	0.025
post (years)	(0.009)	(0.017)	(0.019)	(0.041)	(0.020)	(0.028)	(0.017)
Obs.	2,099	386	376	214	348	255	520
Waiting times × (-1)							
Total time in	0.031***	0.014	0.049**	0.017	0.019	0.002	0.053***
post (years)	(0.009)	(0.021)	(0.022)	(0.028)	(0.021)	(0.028)	(0.017)
Obs.	2,073	384	371	212	343	251	512
Day cases							
Total time in	0.004	0.016	0.010	-0.069**	0.005	-0.007	0.017
post (years)	(0.009)	(0.019)	(0.022)	(0.035)	(0.019)	(0.027)	(0.017)
Obs.	2,097	386	376	214	346	255	520
Length of stay × (-1)							
Total time in	-0.006	-0.002	-0.036	-0.032	0.028	0.041	-0.024
post (years)	(0.009)	(0.020)	(0.022)	(0.032)	(0.022)	(0.026)	(0.016)
Obs.	2,085	383	373	211	344	255	519
MRSA rate × (-1)							
Total time in	0.014	0.010	0.019	0.065**	-0.011	-0.006	0.028
post (years)	(0.009)	(0.023)	(0.023)	(0.030)	(0.022)	(0.027)	(0.018)
Obs.	1,838	327	326	195	305	226	459
Job satisfaction							
Total time in	0.065***	0.088***	0.081****	0.117***	0.060***	0.002	0.054***
post (years)	(0.009)	(0.020)	(0.025)	(0.035)	(0.022)	(0.029)	(0.018)
Obs.	1,775	310	308	193	294	224	446
Directors' pay							
Total time in	-0.033***	-0.008	-0.039**	-0.038	-0.014	-0.029	-0.045***
post (years)	(0.009)	(0.024)	(0.019)	(0.027)	(0.014)	(0.019)	(0.014)
Obs.	2,091	383	375	213	348	252	520

Standard errors in (parentheses). All regressions include a dummy variable indicating that tenure is unsure because we observe the director at this hospital in the first year of our sample period. The hospital-by-director effects are the η_{ij} in Equation 4 for the hospital production measures and in Equation 5 for directors' pay. All hospital-by-director effects have been standardized to have mean = 0 and standard deviation = 1. The hospital-by-director effects for waiting times, length of stay and MRSA rate have been multiplied by -1, so more is always better. *Significant at 10%, **significant at 5%, ***significant at 1%

Table W-7: Association between directors' total time in post at a hospital and the corresponding hospital-by-director effect (larger effect means better performance)

		Model 1	Model 2
Surplus	Total time in post	0.026*** (0.009)	
	3 to 4 years		0.18*** (0.05)
	5 to 8 years		0.12** (0.06)
	9+ years		0.17* (0.09)
	Obs.	2,099	2,099
Waiting times	Total time in post	0.031*** (0.009)	
	3 to 4 years		0.09* (0.05)
	5 to 8 years		0.15*** (0.06)
	9+ years		0.30*** (0.09)
	Obs.	2,073	2,073
Day cases	Total time in post	0.004 (0.009)	
	3 to 4 years		0.03 (0.05)
	5 to 8 years		0.04 (0.06)
	9+ years		0.01 (0.09)
	Obs.	2,097	2,097
Length of stay	Total time in post	-0.006 (0.009)	
	3 to 4 years		-0.12** (0.05)
	5 to 8 years		-0.03 (0.06)
	9+ years		-0.06 (0.09)
	Obs.	2,085	2,085
MRSA rate	Total time in post	0.014 (0.009)	
	3 to 4 years		0.08 (0.06)
	5 to 8 years		-0.02 (0.06)
	9+ years		0.16* (0.10)
	Obs.	1,838	1,838
Job satisfaction	Total time in post	0.064*** (0.009)	
	3 to 4 years		0.20*** (0.06)
	5 to 8 years		0.36*** (0.06)
	9+ years		0.47*** (0.10)
	Obs.	1,775	1,775
Directors' pay	Total time in post	-0.033*** (0.009)	
	3 to 4 years		-0.16*** (0.05)
	5 to 8 years		-0.12** (0.06)
	9+ years		-0.26*** (0.09)
	Obs.	2,091	1,775

Standard errors in (parentheses). The omitted category in Model 2 is 1 to 2 years in post. All models include a dummy variable indicating that tenure is unsure because we observe the director at this hospital in the first year of our sample period. The hospital-by-director effects are the η_{ij} in Equation 4 for the hospital production measures and Equation 5 for directors' pay. All hospital-by-director effects have been standardized to have mean = 0 and standard deviation = 1. The hospital-by-director effects for waiting times, length of stay and MRSA rate have been multiplied by -1, so more is always better. *Significant at 10%, **significant at 5%, ***significant at 1%

Additional pay results Table W-8 presents the correlations between the hospital-by-director effects in pay and the hospital-by-director effects in hospital production separately for each of the board positions, showing similar results across the different positions.

Table W-8: Correlations between hospital-by-director effects in pay (larger effect means more pay) and hospital production (larger effect means better performance) for each of the board positions

	All directors	CEOs	Finance Directors	COOs	Nursing Directors	HR Directors	Other directors
Surplus							
r(pay, surplus)	-0.21***	-0.35***	-0.33***	-0.27***	-0.26***	-0.26***	-0.14***
Obs.	7,710	1,606	1,309	684	1,270	936	1,905
Waiting times × (-1)							
r(pay, wait)	-0.06***	-0.03	-0.18***	-0.09**	-0.07**	-0.13***	-0.03
Obs.	7,543	1,576	1,278	674	1,240	917	1,858
Day cases							
r(pay, day)	-0.11***	-0.02	-0.14***	-0.10***	-0.13***	-0.14***	-0.22***
Obs.	7,663	1,597	1,299	682	1,260	931	1,894
Length of stay × (-1)							
r(pay, length)	0.26***	0.33***	0.33***	0.29***	0.31***	0.33***	0.27***
Obs.	7,640	1,584	1,293	679	1,259	933	1,892
MRSA rate × (-1)							
r(pay, MRSA)	-0.21***	-0.31***	-0.24***	-0.14***	-0.23***	-0.28***	-0.24***
Obs.	6,799	1,325	1,161	625	1,143	846	1,699
Job satisfaction							
r(pay, job)	-0.10***	-0.08***	-0.17***	-0.15***	-0.13***	-0.13***	-0.14***
Obs.	6,297	1,195	1,071	589	1,047	787	1,608

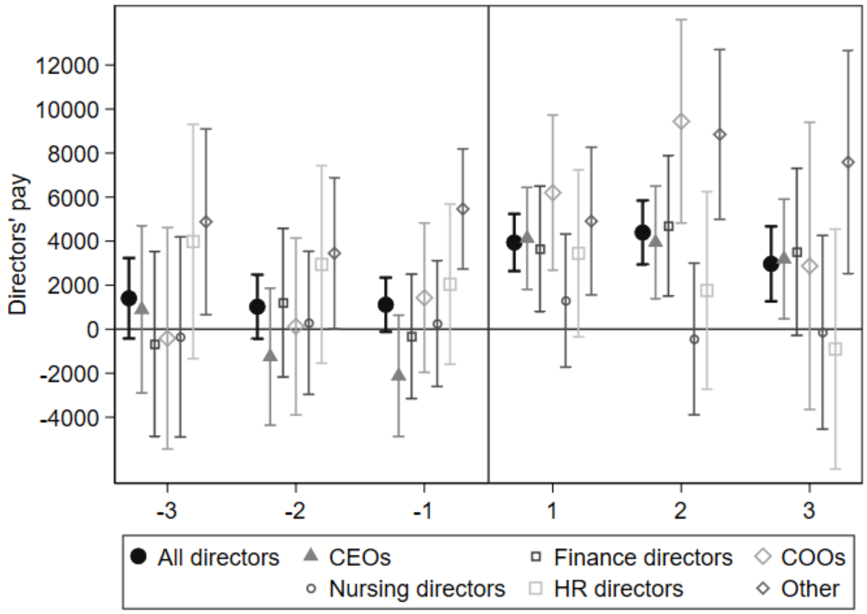
Each cell shows the correlation between the hospital-by-director effects in pay and the hospital-by-director effects in the hospital production measure indicated in the row title. The hospital-by-director effects for waiting times, length of stay and MRSA rate have been multiplied by -1, so more is always better. The hospital-by-director effects for pay are the η_{ij} in Equation 5 and the hospital-by-director effects for the hospital production measures are the η_{ij} in Equation 4. *Significant at 10%, **significant at 5%, ***significant at 1%

Figures W-3 and W-4 present the results from the event study of pay and performance before and after a move separately for each of the board positions.

To investigate if the market is short-sided on the director side, we repeat the event study in Equation 7, allowing for managers moving to more prestigious hospitals (as defined in Section 5.4) to have different pay jumps on moving by interacting the indicator variables $observe^{m}_{i(j,t)jt}$ with a dummy variable indicating the status of hospital j in year t.[45] The results are in Figure W-5a. This shows that more prestigious hospitals pay more

[45]To generate the dummy variable indicating that a hospital is large based on their number of beds

Figure W-3: Pay of movers before and after moving for each of the board positions



Note: Figure displays the coefficients κ_m in Equation 7 and their 95% confidence intervals for all directors. Coefficients for the different board positions are obtained by estimating Equation 7 with interactions between the indicator variables $observe^m_{i(j,t)jt}$ and dummy variables indicating the board level position of director i at hospital j in financial year t.

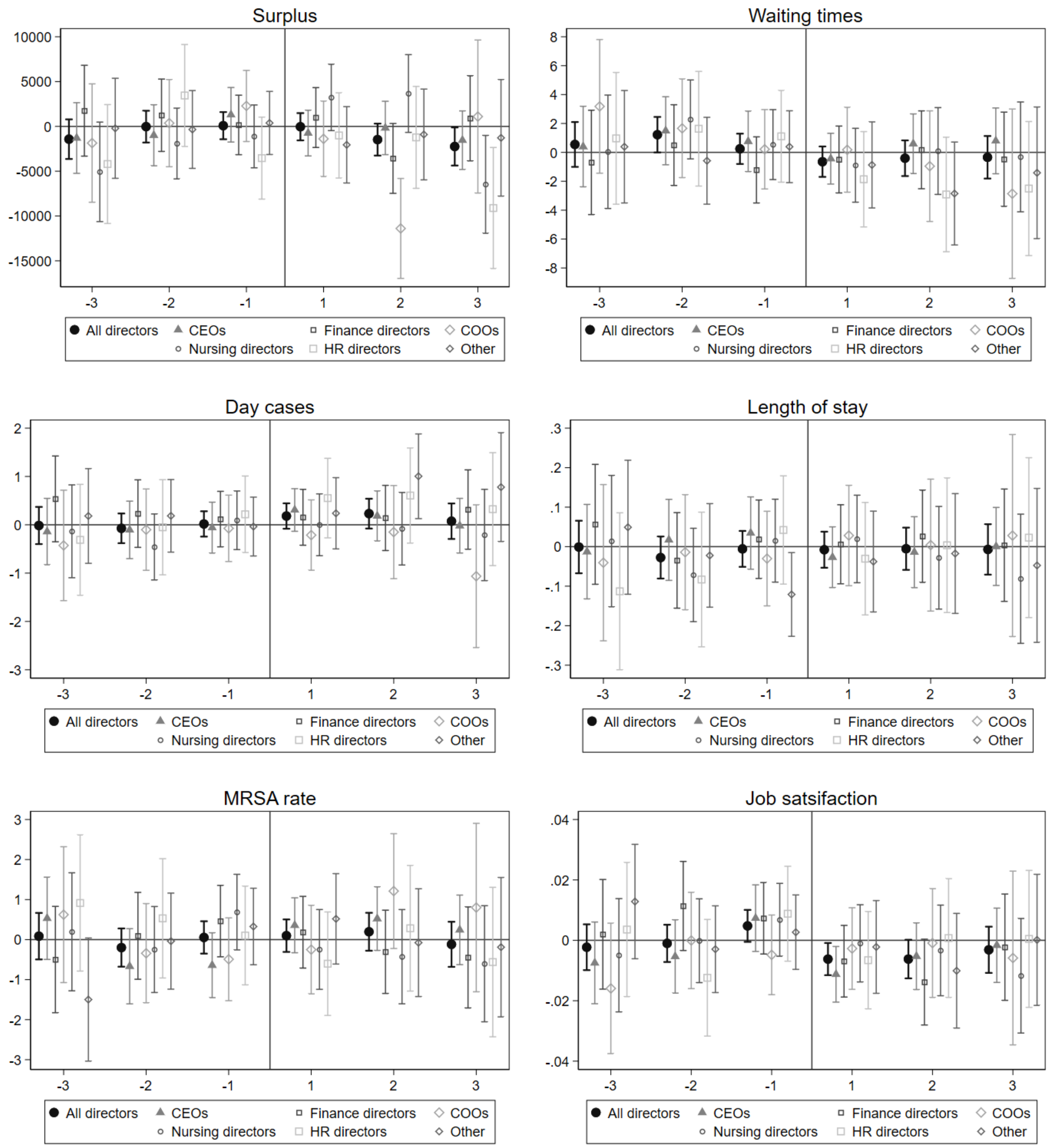
to attract directors, suggesting a shortage of directors.

To further examine the short-sided market hypothesis, we examine whether there is less of a pay jump for movers in those years when hospital demand for directors is (plausibly exogenously) lower. We exploit the fact that the UK government closed or merged some hospitals during the period we study. These closures mean that in certain years there are fewer posts available for top directors and in those years the market would be less short-sided on the director side. Thus, we would expect the pay jumps on moving to be smaller in these years, because there would be more managers on the market relative to the number of hospitals which were hiring. To examine this hypothesis, we re-estimated Equation 7 with interactions between the indicator variables $observe^m_{i(j,t)jt}$ with a dummy variable indicating that there are going to be at least two hospital exits in the following year. Figure W-5b shows that pay jumps were lower in years in which there were fewer slots for top directors.

But other explanations may be at play. The patterns in pay jumps on moving also fit

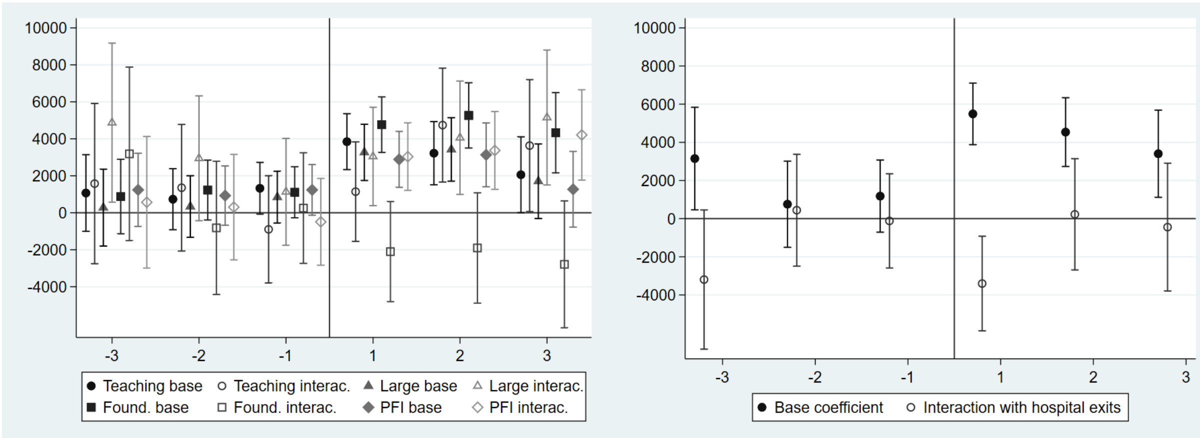
being at or above the 75$^{\text{th}}$ percentile we use the number of beds at the post-move hospital in the year before the director moved there for the interactions with the post-move indicators and the number of beds at the pre-move hospital in the current year for the interactions with the pre-move indicators.

Figure W-4: Hospital production of movers before and after moving



Notes: Figure displays the coefficients κ_m in Equation 8 and their 95% confidence intervals for all directors. Coefficients for the different board positions are obtained by re-estimating Equation 8 with interactions between the indicator variables $observe^m_{i(j,t)jt}$ and dummy variables indicating the board level position of director i at hospital j in financial year t.

Figure W-5: Pay of movers before and after moving to a prestigious hospital and during years with hospital exits



(a) Indicators of prestigious hospital (b) At least two hospital exits in following year

Note: Figures displays the coefficients κ_m in Equation 7 and the coefficients on interactions between $observe^{m}_{i(j,t)jt}$ and the indicated dummy variables as well as their 95% confidence intervals for all directors.

with a market that operates as other labour markets: a pay increase is needed to induce a move and the pay increase needed to attract a top director is lower when there are more directors in the market relative to the number of firms that are hiring. In contrast with other markets, however, these pay changes do not appear to be associated with better performance.

Finally, it may also be the case that the market for NHS top directors is characterised by a compressed talent distribution because salaries are low compared to those in the private sector for firms of comparable size and complexity. In this case, hospitals needing a new manager would not have any incentive to distinguish between a good and a bad manager when hiring. They simply would seek to hire someone and to attract them they would have to increase pay.

Whichever explanation is correct, our results suggest that using pay to attract directors to improve production is not a strategy that appears to result in production gains. Instead, a better strategy for a hiring committee could be simply to hire the best managers they can attract on the market and let managers and hospitals develop a match, rather than hiring for one.

Comparison of mover and non-mover directors A comparison of the attributes of mover and non-mover CEOs and all directors in Table W-9 indicates that movers do not have better long term performance and there are few differences in personal attributes between mover and non-mover CEOs. We have data on personal attributes only for CEOs and not other directors. We hand-collected data on CEO characteristics using online sources such as LinkedIn, hospital websites and local newspapers. The attribute "public honour" refers to the British honours system, which recognizes people who have made achievements in public life. Titles bestowed on hospital CEOs include Knight, Dame, Commander/Officer/Member of the Order of the British Empire (CBE/OBE/MBE).

The only observable difference in personal attributes is that mover CEOs are more likely to have a postgraduate management qualification. Thus, in general movers do not appear to be any better at meeting key hospital objectives than non-movers.

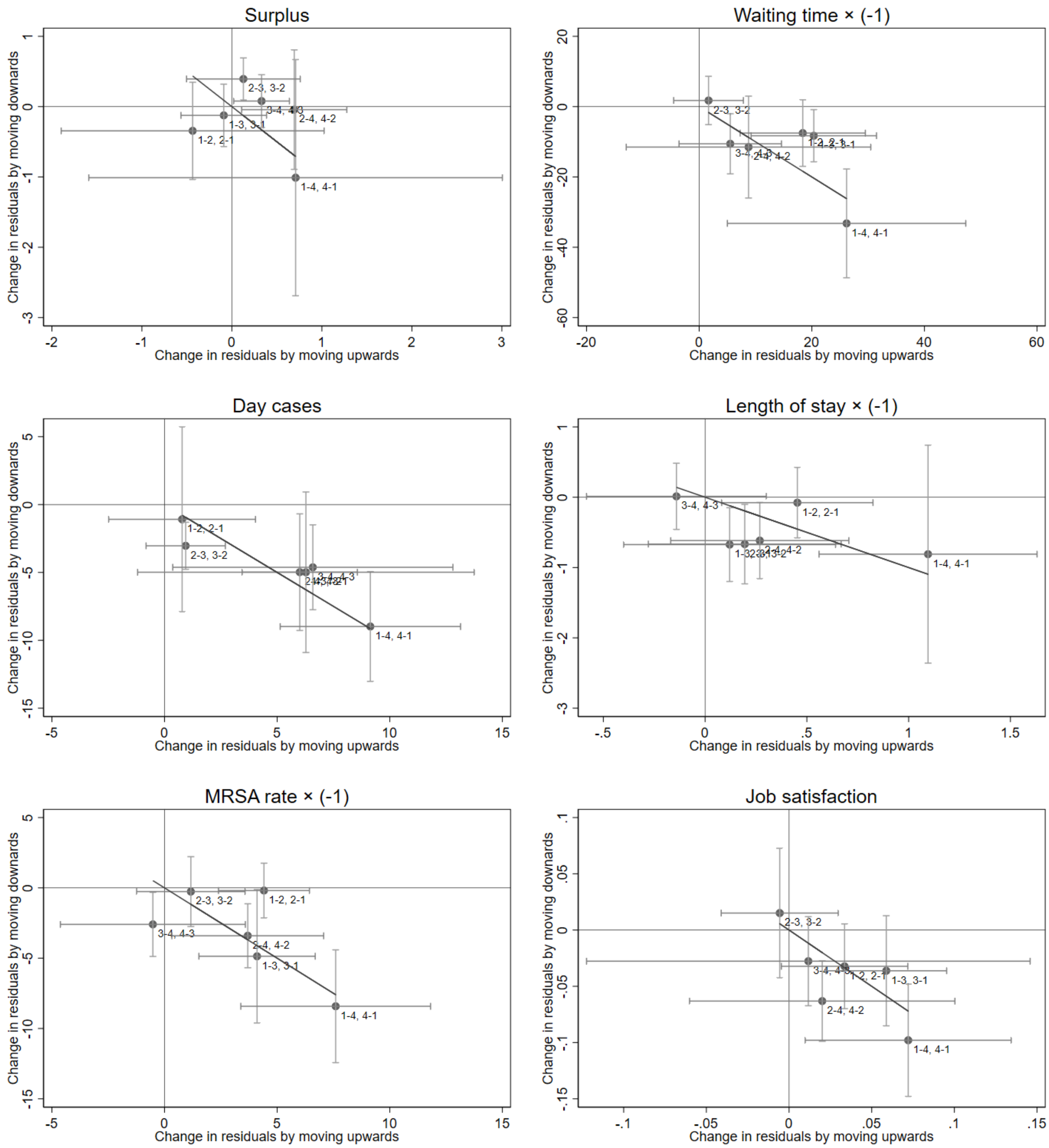
Confidence intervals for symmetry plots Figure W-6 presents the symmetry plots from Figure B-2 with confidence intervals for the change in residualised hospital production measures for director moves from lower- to higher-performing hospitals on the x-axis and confidence intervals for the change in residualised hospital production measures for moves in the opposite direction on the y-axis. Figure W-7 presents the symmetry plot from Figure B-3 with confidence intervals. We see that for nearly all of the points the 95% confidence intervals or the “confidence boxes” created by the combination of confidence intervals overlap with the 45 degree line.

Table W-9: Means of director effects in hospital production for movers and non-movers and characteristics of CEOs by mover status

	All directors			CEOs		
	Movers (SD) [Obs.]	Non-movers (SD) [Obs.]	Difference t-statistic (p-value)	Movers (SD) [Obs.]	Non-movers (SD) [Obs.]	Difference t-stat./χ^2 (p-value)
Surplus	-11.07	-11.06	-0.01	-11.03	-11.07	0.04
(£0,000,000)	(0.96)	(1.08)	-0.25	(0.89)	(1.14)	0.29
	[455]	[1,077]	(0.80)	[160]	[159]	(0.77)
Waiting times	91.77	92.00	-0.23	92.55	91.72	0.83
	(8.94)	(12.16)	-0.37	(8.84)	(11.98)	0.70
	[447]	[1,068]	(0.71)	[158]	[158]	(0.48)
Day cases	26.55	26.59	-0.04	26.39	27.12	-0.73
	(2.06)	(3.10)	-0.25	(2.05)	(3.52)	-2.26
	[455]	[1,075]	(0.80)	[160]	[159]	(0.02)
Length of stay	-2.62	-2.61	-0.01	-2.63	-2.66	0.03
	(0.32)	(0.47)	-0.38	(0.35)	(0.53)	0.50
	[453]	[1,068]	(0.71)	[159]	[158]	(0.61)
MRSA rate	26.05	25.91	0.14	26.16	25.77	0.39
	(2.82)	(4.03)	0.58	(2.63)	(4.28)	0.88
	[367]	[1,021]	(0.56)	[129]	[148]	(0.38)
Job satisfaction	3.505	3.502	0.003	3.503	3.502	0.001
	(0.03)	(0.05)	0.82	(0.003)	(0.005)	0.16
	[374]	[961]	(0.41)	[125]	[142]	(0.87)
Female				32.50%	31.45%	0.05
				[160]	[159]	0.04
						(0.84)
Clinical background				26.25%	23.90%	2.35
				[160]	[159]	0.23
						(0.63)
Postgraduate management qualification				35.63%	20.75%	14.88
				[160]	[159]	8.71
						(0.003)
Private sector experience				11.25%	8.81%	2.44
				[160]	[159]	0.53
						(0.47)
Public honour				13.75%	13.21%	0.54
				[160]	[159]	0.02
						(0.89)

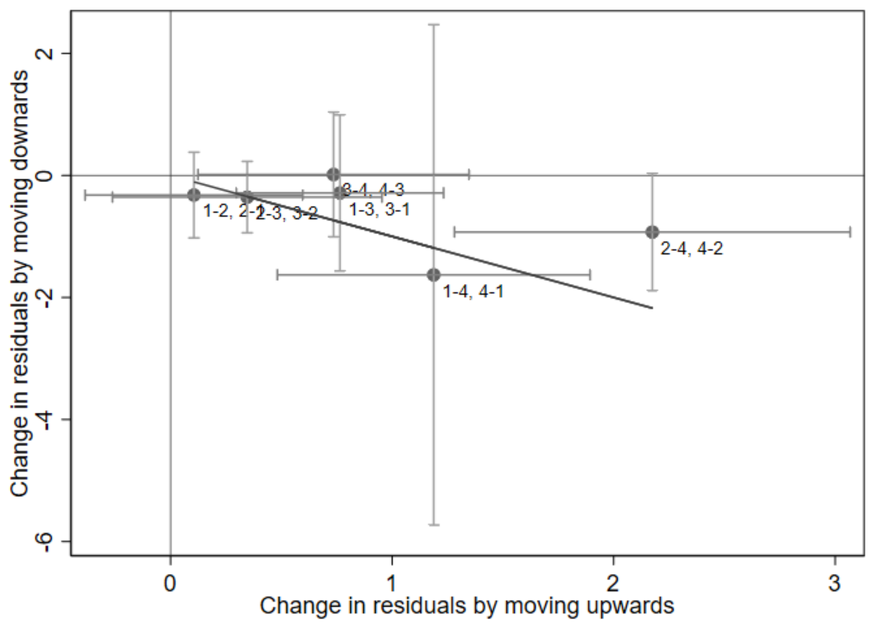
t-statistic from two-sample t-test with equal variances. χ^2 from Pearson's chi-square test.

Figure W-6: Means of change in residualised hospital production measures for director moves from lower- to higher-performing hospitals versus means of change for moves in the opposite direction with confidence intervals



Notes: See notes for Figure B-2.

Figure W-7: Means of change in residualised directors' pay for director moves from lower- to higher-paying hospitals versus means of change for moves in the opposite direction with confidence intervals



Note: See notes for Figure B-3.