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Impacts of provider funding levels and types on demand and supply aspects of access to primary care

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Abstract

Despite growing evidence on how funding influences primary care provider behaviour and patient health outcomes, its effects on access are less known. We assessed the effect of payments to general practices on multiple dimensions of access in England. We used an unbalanced panel of 7,446 general practices between 2015 and 2023, linking payments to patients' satisfaction with access and characteristics. In line with the Levesque framework, we distinguished between supply-side (provider approachability, availability, and appropriateness) and demand-side (patient ability to perceive need, reach care, and engage with care) aspects of access. We used linear two-way fixed-effects models to estimate the effects of payments, in total and by type (capitation, quality-based, activity-based, others). We estimated heterogeneous effects by stratifying practices into quintiles of need, deprivation, and population size. Higher total payment improved all access domains, with bigger gains in more deprived and in larger practices. Payment types demonstrated distinct patterns across aspects of access and practices. Capitation increased patient ability to reach care, but reduced provider capacity to deliver care in lower-need and in larger practices. Quality-based payments increased providers' appropriateness and patients' engagement in lower-need and in larger practices. Activity-based payments showed modest positive associations with access. The positive effects of other payments were driven by dispensing-related components. Effects were attenuated when controlling for unobserved time-varying heterogeneity with interactive fixed-effects. Payment types shape different dimensions of access, with effects varying by population need, deprivation, and size. A balanced payment-mix is essential to support intended context-specific improvements in access.

Keywords: Primary care, provider payment, healthcare access, inequality, England NHS

JEL classifications: I11, I13, I14

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1. Introduction

Access to primary care is essential to improve population health, particularly for those with the greatest need (Starfield et al., 2005). Studies show that access barriers differ across population groups, dimensions of access, and country settings (Corscadden et al., 2017; Corscadden et al., 2018; Gordon et al., 2020; Voorhees et al., 2022). When these barriers accumulate, they also affect healthcare utilisation patterns, including, for example, increased reliance on hospital services (Parkinson et al., 2021; Whittaker et al., 2016).

Strengthening access requires both adequate financial resources and their strategic allocation through different types of provider payment. A blended provider payment model, with need-based capitation payment as its core, has been widely recommended to promote equity and align service provision with population health needs (Hanson et al., 2022; McGuire, 2011). Complementary payments, such as quality-based and activity-based (or fee for service) payments, are often used alongside capitation to support additional objectives such as quality improvement or chronic condition management (Hanson et al., 2022; Langenbrunner et al., 2009). Blended payment schemes have been adopted in many healthcare systems, including the English National Health Service (NHS) (Lefevre et al., 2023; NHS Health and Social Care Act, 2012).

There is growing evidence on how blended payments are associated with provider behaviour, service volume, and healthcare outcomes such as patient satisfaction and mortality (Almström et al., 2025; Barham & Milliken, 2015; Brosig-Koch et al., 2017; Kongstad et al., 2025; L'Esperance et al., 2021; Martin et al., 2023; Or, 2001; Oxholm et al., 2019; Skovsgaard et al., 2023). However, less attention has been paid to intermediate outcomes such as access, and to how these effects vary across population subgroups (Chavarría Pino, 2024; Gallet & Doucouliagos, 2017; Or, 2001; Singh, 2014) and provider characteristics. This is a notable gap given that access represents the critical interface through which financial inputs translate into health outcomes. Moreover, concerns have been raised about the unequal distribution of access and the possibility that different payments may affect certain population subgroups more than others (Alshamsan et al., 2010; Corscadden et al., 2018). These concerns underscore the importance of understanding not only how different payments affect access on average, but also how these effects differ for populations that are the primary focus of equity-oriented reforms.

Limited existing evidence, largely concentrated in England, suggests that increased primary care funding is associated with higher patient satisfaction (L'Esperance et al., 2021; L'Esperance et al., 2019; L'Esperance et al., 2017), self-reported health (Gravelle et al., 2008), and reduced mortality (Martin et al., 2023), with funding type influencing the magnitude of these effects. Specifically, performance-based and operational payments have shown stronger effects on satisfaction compared with capitation (L'Esperance et al., 2020). Evidence globally shows that capitation payments can lead to under-provision of care (Kongstad et al., 2025; Skovsgaard et al., 2023), particularly for high-need populations with more complex needs and facing higher barriers to access, while fee-for-service payments may encourage over-provision (Cashin et al., 2017; Langenbrunner et al., 2009). Blended payment methods are typically adopted to balance these incentives, although their effects on diverse populations remain

unexplored, and the identification of the optimal payment mix remains a context-specific policy challenge.

While access is often discussed in terms of distance, timeliness, and service utilisation, more recent studies have conceptualised it in a multidimensional way to reflect in a more nuanced way how well the services that a provider is offering fit with patient circumstances and needs (Goddard & Smith, 2001; Gulliford et al., 2002; Levesque et al., 2013; McIntyre et al., 2009; Santana et al., 2023). This fit reflects the interaction between supply and demand, which determines patient outcomes such as satisfaction and health. In this study, we use responses to a very large population survey focused on patients' views of primary care. We use the Levesque framework to classify the dimensions of access for which patients report levels of satisfaction into supply-side (provider approachability, availability, and appropriateness) and demand-side (patient ability to perceive need, reach care, and engage with care) aspects of access.

We focus on general practices in England, where the NHS operates with a complex blend of payment schemes for primary medical care and has a strong tradition of needs-based allocations. We use annual data on all practices in England between 2015 and 2022 to assess the effects of payments, in total and by type, on demand-side and supply-side dimensions of access. We categorise payments into four types (capitation, quality-based, activity-based, and others). We present results for all practices and then examine variation across practices serving populations with different levels of population need, deprivation, and size. We use a two-way fixed effect model as the main specification and check its robustness to time-varying unobserved heterogeneity using interactive fixed effects. We found that higher total payment improved all access domains, with more prominent gains in more deprived and in larger practices, but payment types demonstrated distinct patterns, highlighting the importance of the mix of blended payments to achieve intended context-specific objectives. Effects were attenuated but persisted when controlling for time-varying unobserved heterogeneity.

2. Background

2.1 Payments to general practices in England

Funded almost entirely by general taxation, primary care in the English NHS serves as the first point of contact for patients and acts as a gatekeeper to more specialised care through referrals (Cylus et al., 2015). Primary medical care is delivered by general practices (hereafter referred to interchangeably as "general practices" or "practices"), which operate as small-to-medium-sized businesses contracted by NHS commissioners to serve their registered populations. Each practice typically employs a team of general practitioners (GPs), nurses, and administrative staff, though some are single-handed. Every resident register with a single general practice to receive NHS care. Residents can register with a practice of their choice and receive consultations free at the point of use.

Payments to general practices are channelled through multiple schemes that should cover their full-service delivery and operational costs, including service provision, workforce, premises, and pensions. These schemes vary in their purposes, allocation methods, scope of contracted services, and allowable uses of funds (NHS England, 2024). Practices are mostly paid centrally, though since 2015, services

have been co-commissioned locally by Clinical Commissioning Groups (CCGs) (McDermott et al., 2019), which were replaced by Integrated Care Boards (ICB) on April 1, 2022.

We broadly categorised payments to general practices into four types: capitation, quality-based, activity-based, and others (Table 1). Together, these payments form a blended payment, with each type creating different incentives for service delivery. Capitation payments are prospective, based on size and characteristics of the population registered with general practices meeting mandatory requirements for delivering essential services for their registered population. Capitation payments include the Global Sum, Minimum Practice Income Guarantee, and Balance of Personal Medical Service (PMS) Expenditure. The capitation payments represent over half of total payments and are based on a weighted capitation formula developed in 2004, known as "the Carr-Hill formula" (Carr-Hill et al., 1994). This formula is based on the number of registered patients, with adjustments for age and gender, nursing and residential home residents, additional needs, new registrations, local input prices and rurality.

The second type, quality-based payments, comprise retrospective payments made through the Quality and Outcomes Framework (QOF). QOF is a voluntary pay-for-performance scheme in which practices opt in to receive additional payments based on their monitored performance across more than 20 clinical indicators (NHS England, 2023b), with remuneration explicitly tied to measured quality of care.

The third type, activity-based payments, consists mainly of retrospective payments made to practices that voluntarily opt in to provide additional or enhanced services. These payments include components that are tied to the service volume, as well as components that are paid regardless of volume but contingent on delivering specific services. Activity-based payments cover schemes such as Directed Enhanced Services (DES), Local Incentive Schemes (LIS), the Primary Care Network (PCN) Participation payment, non-DES items, and the Winter Access Fund. DES and LIS comprise nationally, and locally agreed schemes designed to address specific health needs within the population, while PCN Participation payment encourage practices to work collaboratively to deliver services at the network level (Checkland et al., 2023; Morciano et al., 2020).

The fourth type, other payments, include retrospective payments related to dispensing and prescribing, as well as prospective payments that support the operational capacity of practices. Dispensing- and prescribing-related payments includes prescribing fees (covering items administered by non-dispensing practices), dispensing fees (applicable to the small number of practices with dispensing status and including associated service fees), and reimbursement of drug costs (which compensates practices for the medications they dispense). General practices are permitted to dispense medicines only for patients who live more than 1 mile (1.6 km) away from the nearest community pharmacy and who have asked their practice to dispense to them. Studies have shown that practices with dispensing status may respond differently to receiving dispensing-related payments than non-dispensing practices (Bodnar et al., 2024; Goldacre et al., 2019; Holdroyd et al., 2026). Operational payments include payments of locum allowances, prolonged study leaves, information technology, premises, and infrastructure maintenance.

The composition of payments varies over time. Most payments were continued throughout the period of our study. Some schemes were introduced in different years, for example General Practice (GP) Transformation fund in 2016, PCN payment in 2019, the COVID-19 payment in 2020, and Winter Access payment in 2021. MPIG was discontinued in 2020/21 following a period of phasing out, with some residual payments continuing into the following years (NHS Digital, 2022a).

Table 1. Payment schemes to general practices by payment type

Payment type	Definition	Payment schemes
Capitation payments	Payments based on size and characteristics of population registered with general practices meeting mandatory requirements for delivering essential services for their registered population.	Global Sum, Minimum Practice Income Guarantee (MPIG), Balance of PMS Expenditure
Quality-based payments	Payments for voluntarily opting in to provide additional services, with compensation tied to the quality of care delivered.	Quality and Outcomes Framework (QOF)
Activity-based payments	Payments for voluntarily opting in to provide additional services, including compensation tied to service volume and compensation paid irrespective of volume, but contingent on delivering specific services.	Directed Enhanced Services (DES), Local Incentive Schemes (LIS), Primary Care Network (PCN) Participation payment, Non-DES Item, and Winter Access Fund.
Other payments	Payments supporting operational capacity and activities related to dispensing and prescribing.	Dispensing- and prescribing-payments (dispensing fee, prescribing fee, reimbursement of drug), Premises, Primary Care Organisation (PCO) administered, Information management and technology, General Practice Transformation, Others, COVID-19.

Notes: We did not include other Primary Care Network (PCN) payment schemes (i.e., Additional Roles Reimbursement Scheme, PCN support payments, Core PCN funding, Clinical Director contributions, Extended Hours Access, and the Care Home Premium) as practice-specific payment amounts are unavailable because these payments are issued to a nominated lead practice and then distributed across all practices within the PCN. Detailed description of each payment schemes, including payer and time-period, in Supplementary Appendix A Table A1.

2.2 Conceptual framework of healthcare access

The concept of healthcare access has been widely studied in different streams of literature and is generally recognised as a multidimensional concept (Goddard & Smith, 2001; Gulliford et al., 2002; Levesque et al., 2013; McIntyre et al., 2009; Santana et al., 2023). In the health economics literature, access is increasingly conceptualised as the inter-relationship between supply, need, and need-based demand (Goddard & Smith, 2001; McIntyre et al., 2009; Santana et al., 2023). From the perspective of public health literature (Gulliford et al., 2002; Levesque et al., 2013), supply is further described in terms of the multidimensional capacities of providers, while need-based demand is described in terms of the multidimensional abilities of populations. The interactions of these specific demand and supply dimensions shape healthcare access and subsequent outcomes.

Levesque et al. (2013)'s conceptual framework was developed to evaluate access through both provider capacities (supply) and population abilities (demand), and has been validated and applied in multiple empirical studies in primary care settings (Corscadden et al., 2017; Corscadden et al., 2018; Cu et al., 2021; Gordon et al., 2020; Sibley & Glazier, 2009; Voorhees et al., 2022; Ward et al., 2014). The framework outlines five dimensions of access resulting from paired aspects on the provider and patient side (Appendix A Figure A1):

- Provider capacities: *Approachability, acceptability, availability, affordability,* and *appropriateness*.
- Patient abilities: Ability to *perceive, seek, reach, pay*, and *engage* in care.

Along each of the five dimensions, access arises when these capacities and abilities align, and barriers may emerge when mismatches occur on either side. For example, a study in Canada found that among self-perceived unmet needs categorised as *availability, acceptability*, and *accessibility*, the most common reason involved mismatches on the supply side due to lack of provider *availability* that led to long wait times. The second most common reason involved mismatches on the demand side: patients' ability to *seek* care was constrained by personal preferences or life circumstances not directly related to provider characteristics (Sibley & Glazier, 2009)

2.3 Theoretical effect of payment types on healthcare access

We used Levesque's framework to analyse the effects of payments on distinct dimensions of access, excluding *acceptability* (ability to *seek*) due to lack of data and *affordability* (ability to *pay*) because care is free at the point of delivery in England. Due to the nuanced definition of access, this framework is helpful to illustrate how specific funding types are expected to influence different dimensions of access for practices serving populations with different characteristics.

Weighted capitation payments provide predictable and flexible funding that should align resources with population needs. Additional resources for patients with higher needs may contribute, for example, to support continuity and team-based care (Frieden et al., 2023; Hanson et al., 2022; Murante et al., 2017), which has been shown to potentially improve equity and cost containment in several international health systems (Anselmi et al., 2015; Frieden et al., 2023). As funding is not tied to service volume or performance targets, practices have greater autonomy to focus on outcomes that matter for patients (Langenbrunner et al., 2009). Evidence from European settings suggests that they are associated with higher patient-perceived responsiveness (Murante et al., 2017). However, recent global evidence shows that a higher share of capitation payment has been linked to lower service volumes, including for complex patients, raising concerns about potential incentives for under-provision (Kongstad et al., 2025; Skovsgaard et al., 2023). Nevertheless, evidence is still limited on whether capitation payment alone can improve different access dimensions besides utilisation. Building on the existing evidence, we hypothesised that capitation payment will have the strongest effects on providers' capacity to deliver *appropriate* care, given that resources are in principle commensurate with diverse patient needs, and the flexible arrangements should allow their use as best suited to patient needs. Capitation may also improve the population's ability to *perceive*, *reach* and *engage* with care by ensuring the right to register with a practice and fostering continuity. We expected effects on providers' *approachability* and *availability* to be weaker, reflecting evidence of under-provision of care.

Quality-based payments remunerate practices based on the performance including quality of care they provide (Vu et al., 2021; Wagenschieber & Blunck, 2024). Evidence from England, particularly studies examining the effects of introducing the QOF scheme, shows that QOF payments have encouraged the assessment of specified chronic conditions (Alshamsan et al., 2012; Kontopantelis et al., 2013; Sutton et al., 2010), increased the availability of appointments until performance target were met (S. M.

Campbell et al., 2009), influenced individual health behaviours (e.g., smoking cessation) (Fichera et al., 2016), and possibly even reduced long-term mortality (Ryan et al., 2016). However, such incentives have also been found to shift attention away from services not directly linked to payment and to encourage undesired provider behaviour (or "gaming"). For example, evidence from England shows that the QOF, despite improving the recording of conditions, may not improve the management of those conditions (Kontopantelis et al., 2013; Sutton et al., 2010) and may incentivise providers to avoid sicker or more complex patients by exempting those unlikely to meet performance thresholds (Gravelle et al., 2010; Wilding et al., 2022). Building on this evidence, we hypothesised that quality-based payments will most strongly affect patients' ability to *perceive* their need, *engage* with care and providers' *appropriateness*.

Activity-based payments link remuneration to both service volume and compensation paid irrespective of volume, but contingent on delivering specific services. It is reported to incentivise service expansion, proactive outreach, and delivering specific services, but it can also over-incentivise provision of care (Cashin et al., 2017; Langenbrunner et al., 2009). Therefore, we hypothesised that activity-based payments will most strongly influence providers' *approachability* and *availability*, and populations' ability to *reach* and *engage* with care.

Other payments support the operational functioning of a practice, including medicine dispensing and prescribing, infrastructure, and workforce capacity. Operational components such as data systems, workforce safety, and training have been recognised as core elements of primary care financing that help build a more responsive system (Frieden et al., 2023). Therefore, we hypothesised that these payments would most directly influence providers' *approachability*, *availability*, and *appropriateness*.

3. Data

We used publicly available data on access outcomes, and observable registered population and practice characteristics for all general practices in England from different sources linked using the unique practice identifier (practice code). The final dataset after sample selection is an unbalanced panel of 7,446 practices with 55,405 practice-year observations between 2015 and 2023.

3.1 Outcomes

We used data from the General Practice Patient Survey (GPPS) for the years 2015 to 2023, with questions consistent over time (NHS England, 2023a). The survey was conducted quarterly (January–March and July–September) between 2015 and 2017; we use the January–March wave. From 2018, the survey became annual, with the survey period extended to January–April. The GPPS is a national cross-sectional survey of patient access and experience, which collects approximately 900,000 responses per year from a sample of adults registered at all general practices across England. To ensure that responses are representative of practice populations, weights are made available to allow for differential response rates within practices with different characteristics per patient population.

Table 2. Description of outcome variables

Outcome Variables	Description	Question phrasing (*Sub-dimension*)	Answer categories
Consequence:			
Overall experience	Healthcare consequences are shaped by the interactions of provider capacity and population ability collectively.	1. Overall, how would you describe your experience of your GP practice?	1 = Very good; Fairly good 0 = Neither good nor poor; Fairly poor; very poor
Provider ability:			
Approachability	The population facing health needs can identify some form of services provided with transparency of information and outreach activities.	2. Is there a particular GP you usually prefer to see or speak to?	1 = Yes, for all appointments; Yes, for some appointments but not others 0 = No; There is usually only one GP in my GP practice
		3. Generally, how easy is it to get through to someone at your GP practice on the phone?	1 = Very easy; Fairly easy 0 = Not very easy; Not at all easy; Haven't tried
		4. How helpful do you find the receptionists at your GP surgery?	1 = Very helpful; Fairly helpful 0 = Not very helpful; Not at all helpful; Don't know
Availability	The physical existence of health resources with sufficient capacity to provide services, resulting from characteristics of facilities, of urban contexts, of individuals, and of providers.	*5. How satisfied are you with the GP appointment time that are available to you?	1 = Very satisfied; Fairly satisfied 0 = Neither satisfied nor dissatisfied; Fairly dissatisfied; Very dissatisfied; I'm not sure when I can get an appointment
		6. Last time to make a general practice appointment, were you offered appointment to see and speck to someone?	1 = Yes 0 = Yes, but I had to call back closer to or on the day I wanted the appointment
		7. Overall, how would you describe your experience of making an appointment?	1 = Very good; Fairly good 0 = Neither good nor poor; Fairly poor; Very poor
Appropriateness	The adequacy relates to what services are provided and the quality of health services and its integrated and continuous nature.	8. During your last appointment, how good was that GP at giving you enough time, listening to you, and treating you with care and concern?	1 = Very good; Fairly good 0 = Neither good nor poor; Poor; Very poor; doesn't apply
		9. In the last 12 months, have you had enough support from local services or organisations to help you manage your condition (or conditions)?	1= Yes definitely, yes to some extent 0 = No, I haven't needed support, Don't know/ can't say
Population ability:			
To perceive	The ability to perceive the need for care among populations is determined by factors such as health literacy, knowledge of health, and beliefs about health and sickness.	10. During your last appointment did you have confidence and trust in the healthcare professional you saw or spoke to?	1 = Yes definitely, yes to some extent 0 = No not at all, don't know/ can't say
		11. How confident are you that you can manage any issues arising from our condition (or conditions)?	1 = Very confident, fairly confident 0 = Not very confident, not at all confident, don't know
To reach	The notion of personal mobility and availability of transportation, and occupational flexibility that would enable one to reach service providers.	12. When was your last general practice appointment?	1 = In the past 3 months, between 3-6 months, between 6-12 months 0 = more than 12 months ago, I haven't had an appointment since being registered with my current GP practice
To engage	The ability of the population to participate and be involved in decision-making, which is strongly determined by capacity and motivation to participate in care and commit to its completion.	+13. During your last appointment, were you involved as much as you wanted to in the discussion about your care?	1 = Yes definitely; Yes, to some extent 0 = No not at all; Don't know/ doesn't apply

Notes: * The phrasing of question 5 changed from 2017 onward, from "*How convenient was the appointment you were able to get?*" to "*How satisfied are you with the GP appointment time that are available to you?*". +The phrasing of question 13 changed from 2018 onward, from "*Last time you saw or spoke to a GP from your GP surgery, how good was that GP at involving you in decisions about your care?*" to "*During your last appointment, were you involved as much as you wanted to in the discussion about your care?*"

The GPPS includes questions about patient characteristics and their views and experiences on access to general practice. We mapped selected questions on access to domains of Lavesque's framework: providers' *approachability*, *availability*, and *appropriateness*; patients' ability to *perceive*, *reach*, and *engage*; and *overall experience*. (Table 2) We followed a structured approach (Fatimah et al., 2023) and ensure that selected measures from the questions considered were conceptually non-overlapping, not limited to specific population subgroups to allow comparisons, and had sufficient data to allow longitudinal analyses. We identified corresponding questions used in previous studies that have mapped other questionnaires to dimensions and sub-dimensions of Levesque's framework (Cu et al., 2021). In total, thirteen questions were mapped to seven access domains, which serve as our seven outcomes of interest. Each outcome variable was calculated as the weighted average proportion of patients selecting the top two positive, out of five available, response options to the relevant question and averaged across the questions mapped into each outcome variable.

3.2 Practice payments

We used data on NHS payments to general practices between 2014/2015 and 2022/2023 (NHS Digital, 2022a), covering practice level payments for most nationally and locally commissioned services during each financial year. The payments reported constitute almost the totality of the income for general practices, were measured in GBP (£) per registered patient and were adjusted to constant 2022-2023 prices using the Consumer Price Index (Bank of England, 2022).

We did not include other PCN payment schemes (i.e., Additional Roles Reimbursement Scheme, PCN support payments, Core PCN funding, Clinical Director contributions, Extended Hours Access, and the Care Home Premium). This is because practice-specific amounts for these schemes are unavailable, as they are issued to a nominated lead practice and subsequently distributed across all practices within the PCN.

We linked payments in 2014/2015 to 2022/2023 with outcomes in 2015 to 2023. As financial years run from April to March, payments were measured almost a year before and therefore lagged compared with the outcome (January to March).

3.3 Other variables

We used a number of time-varying practice and patient control variables. Practice-level patient characteristics were measured around April of each year from 2014 to 2022 (NHS England, 2023a). We linked outcomes in 2015 to 2023 with lagged control variables in 2014 to 2022. The control variables included the weighted proportions of GPPS respondents who were: female (male as base category); age 24-34, age 35-44, age 45-54, age 65-74, age 75 and older (age 0-24 as base category); self-identifying as Asian, Black or Mixed or Others (including Arab, Any other, and prefer not to say) ethnic background (White as base category). We also control for the proportion of patients: with religion (No religion as base category); with different employment status including part time workers, full-time students, permanently disabled, homecare or unemployed (full-time workers as base category); and health behaviour including former or current smokers (no smoker as base). Finally we control for prevalence of each of the 20 conditions monitored annually in the Quality and Outcomes Framework

(QOF) measured as the proportion of patients included in the practice register for each condition (NHS Digital, 2022b), including: asthma, atrial fibrillation, cancer, coronary heart disease, chronic kidney disease, chronic obstructive pulmonary disease, dementia, depression, diabetes mellitus, epilepsy, heart failure, hypertension, learning disability, mental health, obesity, osteoporosis, palliative care, peripheral arterial disease, rheumatoid arthritis, and stroke and transient ischaemic attack. Missing values were imputed using previous year values for each practice or when this was missing the mean within the CCG. Since we are interested in the total effect of funding on patient access, we do not include controls for practice characteristics that may be affected by funding, and be on the pathway, such as staffing levels.

We classified practices into quintiles of three time-invariant characteristics: average population need in 2019 (hereinafter referred to as "need"), average neighbourhood deprivation of registered patients (hereinafter referred to as "deprivation"), and average registered patients list size over the study period (hereinafter referred to as "list size"). Practices population need reflects expected workload and is the explicit focus of equity-oriented funding policies, while deprivation captures socioeconomic disadvantage that may bring differential care seeking behaviours. Registered population size may influence ability to exploit economies of scale and respond to financial incentives. For example, larger practices may be better able to absorb administrative burden and invest in staffing mixes (Zhao et al., 2026). Need is based on the weighted population element of the NHS primary care allocation formula needs index, published in 2019 (NHS England, 2019), which is based on relative practice workloads, with adjustment for patient age and gender, and deprivation. We attributed deprivation for each general practice as the mean Index of Multiple Deprivation (IMD) score available at the small-area (Lower Super Output Areas (LSOAs), each usually comprising 1,000 to 3,000 people) as published in 2019 (Ministry of Housing, 2019). LSOA-level IMD scores were first weighted by the proportion of a practice's registered patients residing in each LSOA in each year from 2014 to 2022, and then averaged across the study period to construct a time-invariant measure. Practice list size was obtained from the payment dataset and averaged over the study period to generate a corresponding time-invariant measure.

3.4 Sample selection and structure

After linking information from different sources and restricting the sample to observations with linked payment and outcome records, we obtained an initial unbalanced panel dataset covering 7,778 general practices in England from 2015 to 2023 (N=57,166). We excluded practice-year observations listed as atypical in the payment data only when the practices had 750 or fewer registered patients (N=449), following previously used method (L'Esperance et al., 2021). Atypical data refer to observations with substantial fluctuations in practice list size or incomplete data coverage during the year. We also excluded practice-year observations with at least one zero or negative payment types (N=1,038), and those with only one practice-year observation over the time-period (N=264) to avoid overstating statistical significance where fixed effects are employed (Correia, 2015). Following these exclusions, the final analysis sample is an unbalanced panel of 7,446 practices with 55,415 practice-year observations, representing 97.5% of the total practice-year observations and 95.7% of the total practices in the initially linked dataset.

We imputed missing values for the prevalence of QOF conditions and GPPS patient characteristics. We imputed 60 practice-year observations of GPPS patient characteristics and 15 practice-year observations of QOF, primarily for practices with incomplete returns, by carrying forward values from the same practice in the previous year, assuming these practice-level variables do not change substantially between consecutive years. When previous-year data were unavailable, we used the mean value of practice within the same CCG in the given year to impute the missing values, assuming that these characteristics within a given CCG are likely to be similar. We imputed an additional 62 practice-year observations for GPPS patient characteristics and 14 for prevalence of QOF conditions.

4. Methods

4.1 Average effects

We estimated the effects of payments per-patient, in total and by type, on access outcomes, using a linear Two-Way Fixed Effects (TWFE) model. The TWFE model compares changes within practices over time, while controlling for unobserved time-invariant characteristics at the practice level (e.g., contract type, rurality) and shocks affecting all practices during a given period (e.g., COVID-19, policy change).

Specifically, we estimated Equation (1) separately for each outcome:

$$lnY_{i,t} = \beta_0 + \beta_1 lnPAY_{i,t-1} + \eta X_{i,t-1} + \delta_i + \tau_t + \varepsilon_{it} \quad (1)$$

where $lnY_{i,t}$ is the log-transformed outcome variable for general practice *i* at time *t*. To account for year-specific idiosyncratic shocks that affect both access and payment, we used the log-transformed lagged per-patient total payment to general practice *i*, denoted as $lnPAY_{i,t-1}$, We prefer a log–log functional form as it allows coefficients to be interpreted as elasticities which facilitate comparison across different payment types and outcomes. We accounted for time-varying characteristics by adding a vector of lagged controls $X_{i,t-1}$. δ_i represents practice fixed effects, τ_t represents year fixed effects, and ε_{it} is the error term and captures the remaining unobserved effects. The parameter of interest, β_1, represents the percentage change in the outcome at time *t* associated with a 1% change in payment per patient at time *t-1*. We used Ordinary Least Squares, with robust standard errors clustered at the practice level and weighting by the size of the practice registered population. We estimated separate regressions for each of the outcomes, including *approachability, availability, appropriateness, perceive, reach, engage*, and *overall experience*. Multicollinearity was assessed using the variance inflation factor (VIF) and all variables had VIF values below 10.

After assessing the effects of total payment, we assessed the distinct contribution of different payment types by re-estimating Equation (1) and replacing $\beta_1 lnPAY_{i,t-1}$ with $\sum_{m=1}^{4} \beta_1^m \, lnPAY_{i,t-1}^m$ the log-transformed, lagged per-patient payment for each of the four payment types composing the total (capitation, quality-based, activity-based, and other payments). For each outcome, we estimated a single regression that included all four payment types simultaneously, allowing us to assess their conditional associations.

4.2 Heterogeneous effects

We estimated heterogeneous effects by stratifying practices into quintiles of three time-invariant characteristics: need, deprivation, and list size. We estimated heterogeneous effects for both per-patient total payment and each payment type across these quintiles, using the approach described in Section 4.1.

4.3 Sensitivity analyses

First, to address the concern that associations may still reflect endogenous relationships, we replicated our analysis using interactive fixed effects (IFE) adjusted models (Bai, 2009), to assess the robustness of our main specification to any unobserved time-varying heterogeneity. Specifically, we replaced the error term in Equation (1), with total payment and with payments by type, with a factor structure $\varepsilon_{it} = \lambda_i \times f_t + e_{it}$, where f_t is an (r x 1) vector of unobserved time-varying common factors with a heterogeneous effect on provider *i* captured by a (r x 1) vector of factor loading, λ_i; and e_{it} captures the remaining unobserved effects. We determined the number of factors using the eigenvalue-ratio (ER) estimator proposed by Ahn and Horenstein (Ahn & Horenstein, 2013). This approach is helpful as a benchmark to control for any policy changes or health shocks such as COVID-19 affect practices differently depending on their characteristics. However, IFE-adjusted model may be downward biased, excessively control for unobserved practice-year heterogeneity, for example by adjusting for changes on the pathway between funding and access (e.g., staffing levels).

Second, we replicated our analysis by disaggregating other payments category into "dispensing- and prescribing-related payments" and "operational payments" to assess their distinct effects. This reflects evidence that practices with dispensing status may respond differently to dispensing- and prescribing-related payments than non-dispensing practices (Bodnar et al., 2024; Goldacre et al., 2019; Holdroyd et al., 2026). As 851 practice-year observations have zero or negative values for dispensing- and prescribing-related payments or operational payments, we applied the inverse hyperbolic sine transformation to those two payments. This allowed us to retain these observations and maintain a consistent sample size across analyses.

Third, we replicated our analysis by restricting the sample to a balanced panel of 3,904 general practices from 2015 to 2023. The balanced panel may represent practices that remained stable throughout the analysis period, whereas the unbalanced panel consists of practices that either closed or opened during the period.

Lastly, we replicated the analysis by replacing per-patient payment by types with their log-transformed share of the total. Per-patient amounts reflect direct funding level received by the practice, whereas payment shares may reflect the funding composition and the associated incentive structure.

5. Results

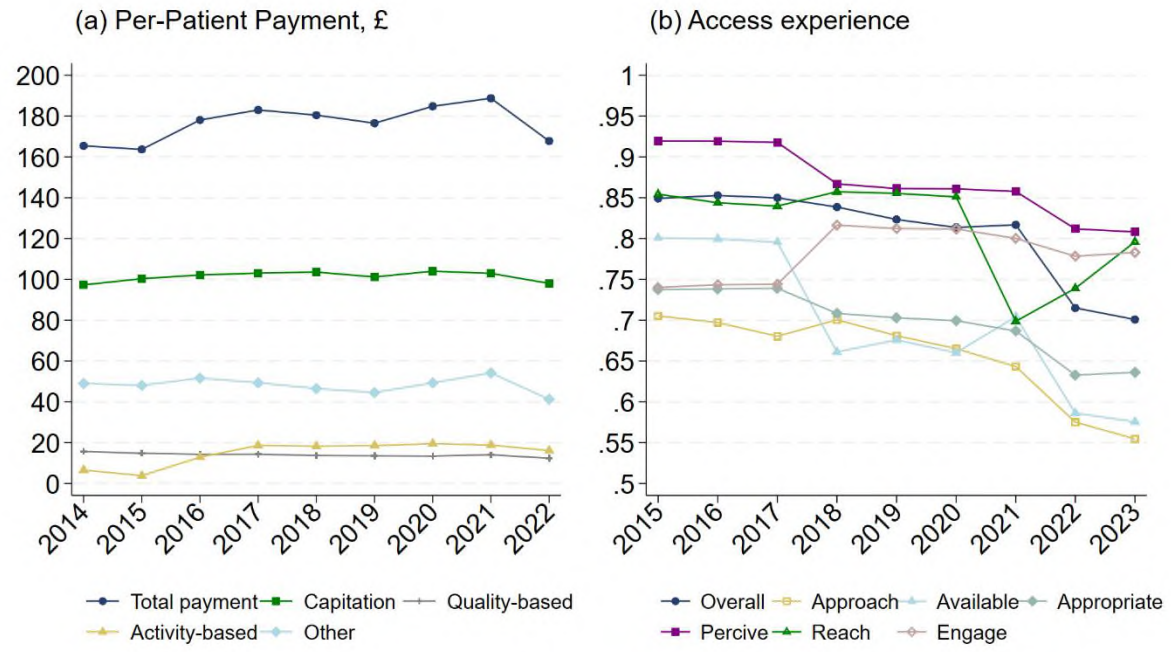
5.1 Descriptive statistics

The average list-size across the 7,446 practices over the time period was 8611. Over time, they on average received payment of £178 per patient, of which £102 were capitation payment, £14 quality-

based payment, £14 activity-based payment, and £48 other payment. On average, registered patients reported 66.2% positive experience with general practice approachability, 70.5% with provider availability, 70.3% with provider appropriateness, 87.5% with their ability to perceive their need for care, 82% reached care in the past 12 months, and 77.9% with engaging in care when they wanted, and an overall positive experience rate of 81.3%. Descriptive statistics are available in Appendix A Table A2.

Figure 1 presents payment and access experience over time. While funding remained mostly stable, the population's experience in access outcomes worsened over time in most domains except the population's ability to engage with care. The declines were especially significant in 2021, likely reflecting the impact of the COVID-19 pandemic. Over the year, patients reported lower levels of positive experience in supply-aspect of access domains (*approachable, availability, appropriateness*) than in their own demand-aspect of access (to *perceive*, to *reach*, to *engage*).

Figure 1. Payment and access experience over time



Notes: (a) Per-patient payments were adjusted to constant 2022-2023 prices using the Consumer Price Index (Bank of England, 2022). (b) The figures show the proportion of practices' registered population reporting positive access experience.

Descriptive statistics across quintiles of need, deprivation, and list size (Appendix A Table A3) show that practices with higher needs and smaller list size received higher per-patient total payment. The distribution of payments across practices varied by payment type. Practices with higher needs, more deprived populations, and a smaller list size received higher per-patient capitation payment. Practices with higher needs, more deprived populations, and larger list size received higher quality-based payment. Practices with higher needs, least deprived populations, and larger list size received higher activity-based payment. Practices with higher needs, least deprived populations, and smaller list size received higher other payment, with higher dispensing- and prescribing-related payment to higher need,

least deprived and smaller practices, and higher operational payment to higher need, more deprived and larger practices.

On average, patients in practices with higher levels of need generally reported better experiences across most access domains, except for utilisation of care in the past 12 months (ability to *reach* care), which remained similar across need quintiles. Patients in practices serving more deprived populations reported fewer positive experiences in most domains but higher utilisation of care in the past 12 months. Patients in practices with larger list size reported fewer positive experiences across most access domains, apart from patients' ability to *perceive* their need for care.

5.2 Average effects

The size of the association between a 1% increase in per-patient payment and the percentage change in patient's overall experience varied by payment type and reduced as more controls were included in the model specification (Table 3).

Using a model without fixed effects nor controls (Column 1), we found a statistically significant positive association between total payment and overall experience (β=0.082, *p-value*<0.001), though the model explained only 1.5% of the variation (Adjusted R^2 = 0.015). When practice fixed effects were included (Column 2), the coefficient decreased and changed sign to -0.04 (p<0.001), while the model fit improved substantially (Adj. R^2=0.426), suggesting that unobserved practice level characteristics accounted for a large portion of the variation and that resources have increased over time toward practices with lower patient satisfaction. Adding also year fixed effects (Column 3) reduced the size of the initial positive coefficient to 0.037 (p<0.001, Adj. R^2=0.661), indicating that temporal shocks, such as COVID-19, may confound the association. Including both fixed effects and the relevant control variables (column 4), slightly reduced the coefficient size to 0.029 (p<0.001; Adj. R^2 = 0.666).

Table 3. Log–log association between lagged per-patient payment and overall experience

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Total payment	0.082***	-0.040***	0.037***	0.029***				
	(0.005)	(0.007)	(0.006)	(0.006)				
Capitation					-0.033***	0.003	0.001	-0.003
					(0.007)	(0.005)	(0.004)	(0.004)
Quality-based					0.098***	0.086***	0.014***	0.012***
					(0.005)	(0.008)	(0.004)	(0.004)
Activity-based					-0.014***	-0.022***	0.003***	0.003***
					(0.001)	(0.001)	(0.001)	(0.001)
Others					0.029***	0.015***	0.009***	0.008***
					(0.002)	(0.002)	(0.002)	(0.002)
Practice FE	X	YES	YES	YES	X	YES	YES	YES
Year FE	X	X	YES	YES	X	X	YES	YES
Controls	X	X	X	YES	X	X	X	YES
Adj. R-squared	0.015	0.426	0.661	0.666	0.064	0.455	0.661	0.667

Notes: Each column reports estimate from an independent regression model with 55,415 practice-year observations (7,445 unique practices). The coefficients represent the percentage change in outcomes associated with a 1% increase in payment per patient. Standard errors clustered at the practice level and weighting by the size of the practice registered population. A */**/*** indicates significant at the 10/5/1% levels. FE, fixed effects. Controls include proportion of patients as female, 6 age bands, ethnicities (Asian, Black, Mixed, Others), economic activities, with religion, prevalence of 20 chronic conditions monitored in primary medical care.

When looking at the distinct effects of payments by type using a TWFE model (Column 8), we find positive and small associations with overall experience, with size and significance varying by type. The effect of capitation was small, negative and not statistically significant (-0.003, *p*=0.444) while the effects of quality-based (0.012, *p*=0.001), activity-based (0.003, *p*=0.003), and other payments were positive and statistically significant (0.008, *p*). Alternative model specifications (Columns 5–7) indicated that unobserved time-invariant practice-level characteristics, temporal shocks, and relevant control variables again confound the associations.

The associations between per-patient payments, in total and by type, and outcomes differed depending on the specific access domain considered (Figure 2 and Appendix A Table A4). A 1% increase in total payment had a statistically significant positive association with patients' experience in provider's *approachability* (0.018, *p*=0.007), *availability* (0.024, *p*=0.004), populations' ability to *perceive* need (0.007, *p*=0.006), *reach* care (0.012, *p*=0.001), *engage* with care (0.012, *p*=0.003), and *overall experience* (0.029, p<0.001). When scaled by the mean outcome, these coefficients indicated that a 10% increase in total payment corresponds to increases of 0.12 percentage points (pp) in *approachability* (mean: 0.662), 0.17 pp in *availability* (mean: 0.705), 0.06 pp in *perceive* (mean: 0.875), 0.1 pp in *reach* (mean: 0.82), 0.09 pp in *engage* (mean: 0.779), and 0.24 pp in *overall experience* (mean:0.813).

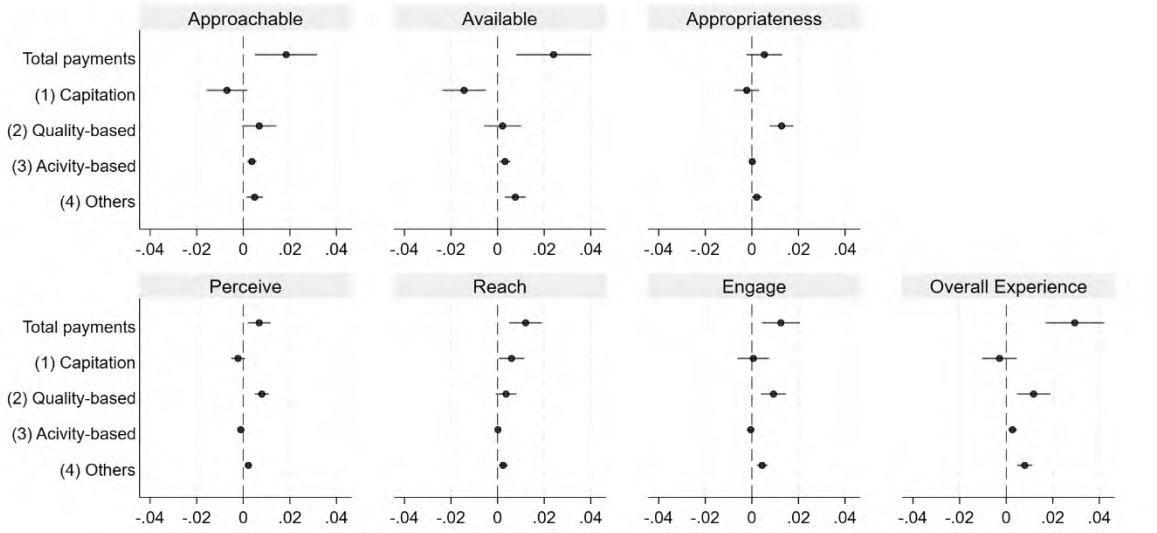
An increase in capitation payment was associated with improved population's ability to *reach* care (0.006, *p*=0.032) but lower provider *availability* (-0.014, *p*=0.003), indicating that a 10% increase in payment corresponded to changes of +0.05 and -0.1 percentage points in these outcomes (at the mean), respectively.

An increase in quality-based payment was associated with improved *approachability* (0.007, *p*=0.069), *appropriateness* (0.013, *p*<0.001), *perceive* (0.008, *p*<0.001), *engage* (0.009, *p*=0.001), and *overall experience* (0.012, *p*=0.001); with an increase of 10% corresponding to improvements of 0.05, 0.09, 0.07, 0.07and 0.1 percentage points in these outcomes, respectively.

An increase in activity-based payment was associated with improved *approachability* (0.004, *p*<0.001), *availability* (0.003, *p*=0.007), *perceive* (-0.001, *p*=0.001), and *overall experience* (0.003, *p*=0.003), with an increase of 10% corresponding to improvements of 0.03, 0.02, 0.009, and 0.02 percentage points in these outcomes, respectively.

An increase in other payments were associated with improved *approachability* (0.005, *p*=0.007), *availability* (0.008, *p*=0.001), *appropriateness* (0.002, p=0.054), ability to *perceive* (0.002, *p*=0.001), *reach* (0.002, *p*=0.016), *engage* (0.004, *p*<0.001), and *overall experience* (0.008, p<0.001). When scaled with mean outcome, a 10% increase in other payments corresponded to 0.03 (approachability), 0.06 (availability), 0.01 (appropriateness), 0.02 (perceive), 0.02 (reach), 0.03 (engage), and 0.007 (overall experience) percentage points in these outcomes, respectively.

Figure 2. Associations between lagged per-patient payment, in total and by type, and outcomes



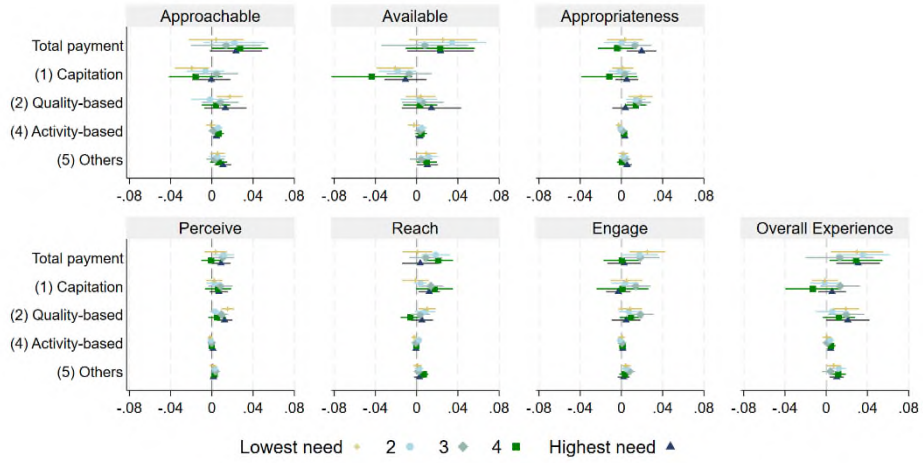
Notes: The figure presents coefficients with 95% confident interval. The coefficients represent the percentage change in outcomes associated with a 1% increase in per-patient payment by type. Coefficients and SE are reported in Appendix A Table A4.

5.3 Heterogeneous effects

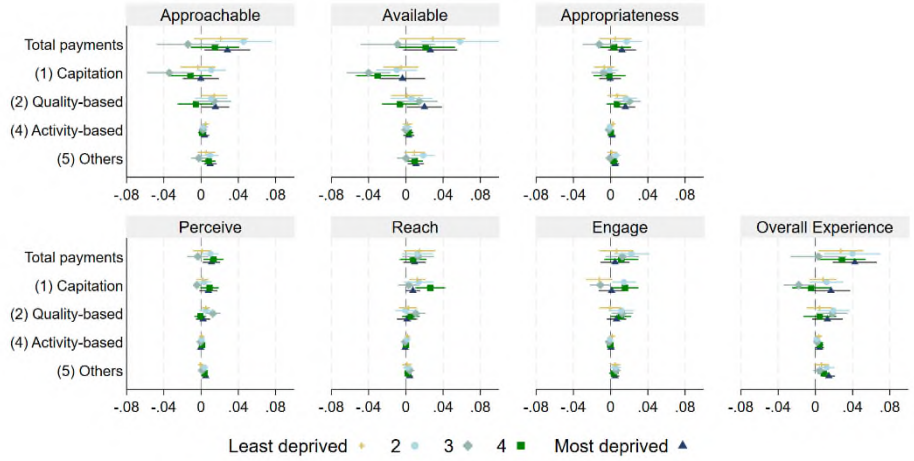
The associations between payments and access outcomes were quite heterogeneous across quintiles of need, deprivation, and list size. (Figure 5) When examining heterogeneous effects by need quintiles (Panel A), we found that total payment showed the larger positive effects only in the highest-need quintile for providers' *appropriateness* and the larger positive effects with patients' ability to *engage* only in the lowest-need quintile. Capitation payments showed larger significant negative effects on *approachability* and *availability* in the lowest-need group, but with larger significant positive effects on patients' ability to *reach* care in the higher-need quintiles, with effect sizes increasing with need across quintiles. Quality-based payments showed the strongest positive effects on *appropriateness* and *reach* in the lower-need quintiles. Activity-based payments showed larger positive effects on *approachability* and *overall experience* in the higher-need quintiles. Finally, other payments showed larger significant positive effects on *approachability* in the higher-need quintiles, with increasing effect sizes at higher need levels. We found variation in effect sizes across deprivation quintiles (Panel B), but no consistent gradient indicating stronger effects on either more- or less-deprived populations. The only exception was total payment, which showed a larger positive association with ability to *perceive*, and *overall experience* in the most deprived quintile. Total payment showed larger significant positive effects on *approachability*, *availability*, and *overall experience* only in the largest practices and larger significant positive effect on *appropriateness* only in the smallest practices (Panel C). Moreover, we found that capitation payment showed stronger significant negative effects on *approachability* and *availability* in larger practices. Quality-based payments showed larger significant positive effects on *appropriateness* and ability to *engage* in larger practices.

Figure 3. Heterogeneous effects across need, deprivation, and list size

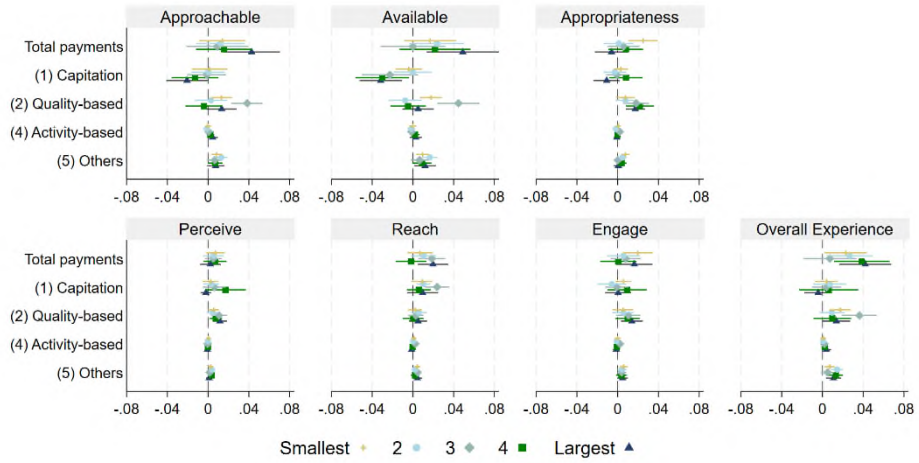
(a) Heterogeneity by need



(b) Heterogeneity by deprivation



(c) Heterogeneity by list size



Notes: The figure presents coefficients with 95% confident interval. The coefficients represent the percentage change in outcomes associated with a 1% increase in per-patient payment, in total and by type, across quintiles of need, deprivation, and list size. Results in table format is reported in Appendix A Table A5-A7.

5.4 Sensitivity analyses

First, results from the IFE-adjusted models (Appendix B) generally showed similar directions of effects with a general attenuation of the estimated coefficients, and several associations losing statistical significance, but with some exceptions. The coefficient between total payment and *appropriateness* reversed signs but remained insignificant. For capitation payments, the negative associations with *approachability* and *appropriateness* became positive and statistically insignificant. For quality-based payments, the positive association with *availability* reversed sign and remained insignificant. The positive association between other payments and *appropriateness* reversed sign and became statistically insignificant. Heterogeneous effects attenuated as well, with several associations losing statistical significance. In particular, the stronger negative associations with *approachability* and *availability* observed for total and capitation payment in larger practices are no longer significant. An exception was heterogeneity by need for quality-based payment which showed larger positive and significant effects with *approachability*, *availability*, *reach,* and *overall experience* only among practices in the highest-need quintile.

Second, results were overall robust to disaggregating other payment into “dispensing- and prescribing-related payment” and “operational payment” to assess their distinct effects (Appendix C). We additionally found that dispensing- and prescribing-related payment were positively associated with most access outcomes, with the strongest associations observed in practices serving higher-need and least-deprived populations. Operational payments were also positively associated with demand-side aspects of access, although the effect sizes were smaller.

Third, we replicated our analysis using a balanced panel of 3,209 general practices observed continuously from 2015 to 2023 (Appendix D). Descriptive statistics show that, compared with the main sample, the balanced panel received on average £4 less in total payment, reflecting the difference in dispensing- and prescribing-payments. The balanced panel also reported approximately 1 to 3 percentage points lower positive access experience. However, average patient characteristics in the balanced panel were similar to those in the main analysis. Overall, results of average effects remain broadly consistent with the unbalanced panel, though coefficients were larger and confidence intervals wider. Exceptions included the associations of capitation and other payments with *reach*, and of quality-based payments with *approachability*, which become statistically insignificant. Heterogeneous effects remained similar in direction but attenuated in size.

Fourth, results using payment shares were also mostly consistent with the main analysis (Appendix E). Exceptions include the positive associations of capitation and other payment shares with *reach*, which lose statistical significance, and the association between the capitation share and *overall experience*, which was positive and statistically significant. We also observed larger negative, though statistically insignificant, associations between the capitation share and supply-aspect of access measures in less-deprived practices.

6. Discussion

We evaluated the effects of payments, in total and by type, on patients' reported experiences of access to general practice in the English National Health Service (NHS) between 2015 and 2023. We used the Levesque framework to classify diverse measures of patient's reported levels of access satisfaction into supply-side (provider *approachability, availability*, and *appropriateness*) and demand-side (patient ability to *perceive* need, *reach* care, and *engage* with care) dimensions. We categorised payments into four types (capitation, quality-based, activity-based and others) with hypothesised distinct effects on different domains of access, reflecting the incentives they create for practices and their alignment with patients' circumstances and needs. We examined heterogenous effects across practices serving populations with different levels of need, deprivation, and registered population list size. We found that payments, in total and by type, have distinct effects on supply-side and demand-side aspects of access in line with theoretical expectation and findings from empirical studies. Results were overall robust to a range of sensitivity analyses including accounting for time-varying practice level unobserved heterogeneity.

Specificity, we found that higher total payment improved most aspects of access, with larger effects on supply-side than on demand-side dimensions of access. This likely reflected that while funding directly affects provider behaviour and service provision, demand-side barriers may be less responsive to total funding alone without targeted strategies to reduce such barriers. We found that capitation payments reduced provider *approachability* and *availability* but increased patients' use of care (*reach*). This likely reflected weaker incentives to expand additional services when payments are not linked to volume, alongside continued support for access through funding essential services and guaranteeing patients' right to register with a practice, as highlighted in previous studies (Frieden et al., 2023; Hanson et al., 2022; Murante et al., 2017; Skovsgaard et al., 2023). In contrast, quality-based payments were associated with improvements in provider *appropriateness* and patients' ability to *perceive* and *engage* with care, reflecting the explicit link between compensation and care quality. Our findings added to previous English studies mostly focused on the QOF (Alshamsan et al., 2012; S. M. Campbell et al., 2009; Fichera et al., 2016; Gravelle et al., 2010; Kontopantelis et al., 2013; Ryan et al., 2016; Sutton et al., 2010; Wilding et al., 2022). Activity-based payments increased provider *availability* and *approachability* by linking renumeration to both service volume and provision of specific services, although the estimated effects were smaller in magnitude. Other payments were associated with improvements across most aspects of access, again with relatively smaller effect sizes.

However, these effects appeared to vary across practices serving population with different levels of need or deprivation, and with different patient list size, characteristics that promote equitable and efficient funding policies. We found that the negative effects of capitation payment were absent in practices serving higher-need, more deprived populations and those with smaller list sizes. In these contexts, capitation payments may be more closely reflect workload and sustain income and activities regardless of demand side- barriers which may reduce payments related to quality and quantity of delivered services. By contrast, the positive effects of quality-based payments with *appropriateness* were concentrated in practices serving lower-need populations and larger list sizes. In these settings

quality targets may be relatively easier to achieve due to less complex clinical demand and greater organisational capacity to implement and deliver remuneration-linked activities efficiently. The positive effects of activity-based payments are concentrated in higher-need practices, likely because activity-linked remuneration increased access the most where underlying demand was higher, but not in more deprived areas where higher demand-side constraints to service use may exist.

Results from the IFE-adjusted model suggested that average and heterogeneous effects were generally robust in terms of direction to additional controls for unobserved time-varying heterogeneity but reduced in size. This is consistent with concerns that this approach may over-control for time-varying unobserved factors that lie on the pathway between funding and access. An exception was heterogeneity by need for quality-based payments, where positive and statistically significant associations with *approachability, availability, reach*, and *overall experience* emerged only among practices in the highest-need quintile. This pattern may reflect that, in high-need settings, accounting for differential time-varying shocks modifies the estimated relationships between quality-based payments and access outcomes relative to the TWFE model, revealing associations that were previously obscured and highlighting need to further understand how different practices respond to different types of payments.

Notably, as shown in the sensitivity analysis, the positive effects of other payments on access were largely driven by dispensing- and prescribing-related payments, with larger effects observed in practices serving higher-need and least-deprived populations. This heterogeneity likely reflects the fact that practices with dispensing status, which received additional remuneration linked to dispensing activity, were disproportionately concentrated in rural and less deprived areas. This finding extended previous studies on physician dispensing and prescribing behaviour (Bodnar et al., 2024; Goldacre et al., 2019; Holdroyd et al., 2026) by showing that renumeration linked to dispensing services may improve patients perceived access to care, despite these gains being unevenly distributed across levels of deprivation.

Restricting the analysis to a balanced panel of more stable practices, as show in our sensitivity analysis, yielded broadly consistent average effects, though estimates are less precise due to reduced variation. Results based on payment shares similarly supported the main findings, but the attenuation and loss of significance for several associations indicated weaker and less precisely estimated associations between funding composition and access outcomes.

Together, our findings extended and complemented previous evidence linking increased primary care funding to lower mortality and higher patient satisfaction (Barham & Milliken, 2015; L'Esperance et al., 2021; Martin et al., 2023), by identifying access as a key intermediate pathway through which financial inputs translate into patient experiences and health. We further contributed to the literature by showing that this mechanism varies by payment type and across practices and population groups, underscoring the importance of designing blended payment systems that are responsive to differences in practice capacity and population need and characteristics in order to support context-specific access objectives.

There are several key strengths of this study. The first key strength is the use of a theory-informed framework, which enables more granular analysis of distinct demand and supply dimensions of access. Examining access through a structured approach and using more nuanced definitions of access,

generate findings that can help commissioners to strategically target funding and providers to collaborate more effectively with patients to improve access. Specifically, we extend Levesque's framework, often used in public health literature, by showing that financial mechanisms are structural determinants shaping the alignment of access between supply (provider capacity) and demand (patient ability). Second, the study employs a rigorous econometric approach with extensive analyses to assess the robustness of results across alternative specifications and to better account for potential sources of bias. Third, our use of publicly available data on most payments to general practices within the English NHS, linked with other practice characteristics, enhances transparency and facilitates ongoing evaluation.

Despite improving upon previous studies, this study is not without limitations. First, our coefficient estimates should be interpreted with caution. While we use lagged payment values to mitigate endogeneity, the appropriate lag period may also vary across different payment schemes, for example prospective and retrospective, according to the time of funding disbursement. Second, the mapping of GPPS survey questions to access domains may still be subjective depending on the perspective and interpretation of the questions. Moreover, the limited availability of certain questionnaire items restricts our ability to map a broader range of outcomes. GPPS survey data may also be subject to recall bias, and the low response rate could lead to imprecise or biased estimates. However, studies have shown that these issues do not significantly compromise the overall reliability of the data (J. Campbell et al., 2009; Davey et al., 2016; Lyratzopoulos et al., 2011). Third, we lacked data to accurately capture time-varying healthcare needs beyond prevalence of long-term conditions and assumed that practice-level measure of relative need is the same across years. Lastly, our reliance on practice-level data limits our ability to assess the benefits for patients with varying levels of need at the individual level and to understand variation within each practice.

Future studies should leverage individual-level data to directly assess the effects of diverse payments on patients and to capture variation within practices. Moreover, since payment schemes aggregated under a single type may differ in their associations with access further disaggregation and analysis of individual payment schemes would be valuable to understand how specific incentives shape different dimensions of access to specific services.

7. Conclusion

We evaluated the effects of English NHS payments to general practices between 2015 and 2023 on multiple dimensions of access. We found that higher total payments were associated with improvements across most access domains, with the largest gains observed in practices serving more deprived populations and those with larger list sizes. Payment types showed distinct patterns. Capitation payment was negatively associated with provider approachability and availability, but positively associated with patients' ability to reach care, with these negative effects largely absent in higher-need and smaller practices. Quality-based payment was associated with improvements in providers' capacity to deliver appropriate care and patients' ability to engage with care, although these effects were evident only in lower-need and larger practices. Activity-based payment was consistently associated with

improvements across most access domains, particularly in practices serving higher-need populations, although effect sizes were relatively small. Finally, positive effects of other payment were driven by dispensing- and prescribing-payment, with the strongest associations found in higher-need and least-deprived practices. Together, these findings show that the level of payment shape different dimensions of access, and that their effects vary by need, deprivation, and practice list size. They further underscore that access is a critical intermediate pathway through which financial inputs influence patients' experiences of care, underscoring the importance of a balanced mix of payment types to achieve intended context-specific access objectives and improvements.

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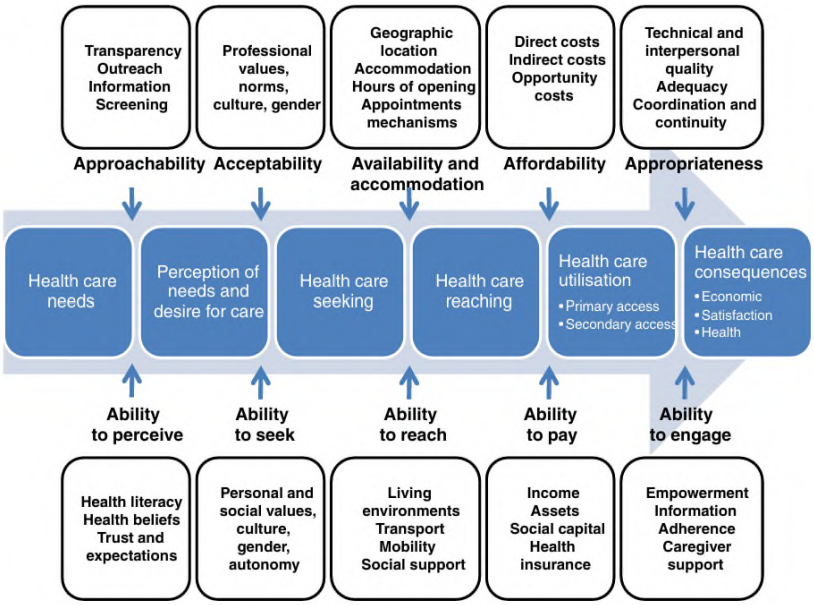
Appendix

Contents

Appendix A: Main analysis

Figure A1. Access to healthcare: a conceptual framework



Source: Levesque et al. 2013.

Table A1. Payment schemes to general practices by payment type

Type	Definition	Payment Schemes	Description	Payer	Time Period in Analysis*
Capitation payments	Payments based on patient need-weights are made to general practices meeting mandatory requirements, delivering essential services, and offering additional agreed-upon services for their registered population.	Global Sum	Global Sum is based on a weighted capitation formula developed in 2004 and known as 'the Carr-Hill formula', which accounts for age and gender, additional needs, list turnover, market forces and rurality. It is allocated to practices that meet mandatory requirements, deliver essential services, and provide additional and out-of-hours services as agreed upon. Although Global Sum Payment is notionally an annual amount, it is to be revised quarterly, and a proportion is paid monthly.	NHS England	2014-2022
		Minimum Practice Income Guarantee (MPIG)	The MPIG was used to top up practices' Global Sum Payments to match their basic income levels, before the new capitation formula was introduced. This has been phased out over seven years (2014 to 2021).	NHS England	2014-2022
		Balance of PMS Expenditure	General practices can voluntarily opt into locally agreed and managed contracts for Personal Medical Services (PMS) with payments also based on the Carr-Hill formula.	NHS England	2014-2022
Quality-based payments	Payments for voluntarily opting in to provide additional services, with compensation tied to the quality of care delivered.	Quality and Outcomes Framework (QOF)	The QOF is a pay-for-performance scheme that rewards practices based on their monitored performance against over 20 clinical indicators, such as hypertension management or asthma care. One part of the QOF payments is paid in advance in respect of previous year achievement, the other part of the payments is paid based on the actual achievement, on the last day of the financial year.	NHS England	2014-2022
Activity-based payments	Payments to provide additional services, with compensation typically based on the volume of services delivered or the performance achieved on a set of pre-specified services	Direct Enhanced Services (DES)	DES includes service fee payments for the Learning Disabilities Health Check Scheme, Minor Surgery, Out-of-Hours Urgent Care, Services for Violent Patients, Medical Assessment Reviews, and Weight Management Services.	NHS England	2014-2022
		Local Incentive Schemes (LIS)	LIS comprises locally developed services to provide extended hours access and meet local health needs. LIS replaced the previous "Local Enhanced Services" and "National Enhanced Services" in 2017.	Local Authorities	2014-2022
		Non-DES Item	Payments for the administration of the Pneumococcal Vaccine and Childhood Immunisation Main Programme.	NHS England	2014-2022
		Winter Access Fund	Payments to build resilience and improve access for patients across winter.	NHS England	2021-2022
		PCN Participation	Practices participated in PCN will be entitled to the network participation payment.	NHS England	2019-2022
Others	Payments for practices that voluntarily opt in to provide additional services, including compensation tied to service volume and compensation paid irrespective of volume but contingent on the specific services delivered.	Premises	Premises payments are reimbursement for the practice's rent or mortgage payments. There are rules on what a practice can use its building for, which affect reimbursement.	NHS England	2014-2022
		Primary Care Organisation (PCO) administered	PCO-administered payments include Seniority payments (payments based upon a GP's years of reckonable service and their qualifying income fraction, phased out by 2020), Doctors' Retainer Scheme Payments (A scheme designed for doctors who are not currently working in touch), Locum Allowances, Appraisal Costs (A payment made to practices to cover costs for GP partners or salaried GPs in preparing and undertaking appraisal), Prolonged Study Leave, and PCO Admin Other.	Local Primary Care Organisation (PCO), the ICB.	2014-2022
		Information management and technology	Payments made to GP to cover the cost of information management and technology services under the GP IT Future framework expired in March 2023	NHS England	2014-2022
		General Practice Transformation	Payments aimed to improve patient care and access under the General Practice Forward View, published in April 2016. This includes expenditure in the Improving Access to General Practice programme, the Estates and Technology Transformation Fund, and the Primary Care Access Recovery Programme.	NHS England	2016-2022
		COVID-19	Payments covering additional costs to support the delivery of the COVID-19 vaccination and management of long COVID-19.	NHS England	2020-2022
		Other	Payments for clinical services that cannot be accurately allocated to other headings due to coding limitations, including trainee payments, trainer grants, and associated costs.	NHS England	2014-2022
		Dispensing and prescribing related payments	Some practices receive prescribing payments, which include prescribing fees, dispensing fees, and drug reimbursement. Prescribing fee payments cover items administered by non-dispensing practices, while dispensing fee payments cover items dispensed by practices with dispensing status and other service fees. Reimbursement of drug costs compensates practices for the medications dispensed.	NHS England	2014-2022

Notes: We did not include other Primary Care Network (PCN) payment schemes (i.e., Additional Roles Reimbursement Scheme, PCN support payments, Core PCN funding, Clinical Director contributions, Extended Hours Access, and the Care Home Premium) as practice-specific payment amounts are unavailable because these payments are issued to a nominated lead practice and then distributed across all practices within the PCN.* These payments are lagged by one year relative to the access outcomes. Source from NHS Digital. *NHS Payments to General Practice*. 2025; Available from: https://digital.nhs.uk/data-and-information/publications/statistical/nhs-payments-to-general-practice.

Table A2. Descriptive statistics

	Mean	SD	1st %	Median	99th %
Payment: per-patient payment, £ (2014-2022)					
Total payment	177.8	62.8	110.7	162.4	424.1
Capitation payment	101.5	21.5	75.6	99.2	156.4
Quality-based payment	14.3	3.8	5.3	14.2	23.8
Activity-based payment	14.2	12.4	0.2	11.9	52.1
Direct Enhanced Services (DES)	3.7	3.7	0	3.6	12.6
Local Incentive Schemes (LIS)	9.4	10.8	0	6.7	44.9
Non-DES	0.1	0.2	0	0.1	0.5
Primary Care Network (PCN) Participation	1.8	0.4	0	1.9	2.5
Winter Access Fund	0.7	3.8	0	0	8
Others	47.9	53.5	5.7	31.8	271.7
Operational payment	29.4	31.7	2	23.2	121.3
Dispensing and prescribing related payment	18.5	42.8	0	5.8	228.8
Dispensing fee	3.2	10.6	0	0	54.3
*Prescribing fee **	0.6	0.9	-3.2	0.8	1.9
Reimbursement of drugs	14.7	32.9	0	4.9	176
Outcomes: proportion of positive experience, % (2015-2023)					
Overall experience	81.3	11.4	47.2	83.4	98.5
Provider approachability	66.2	10.9	37.8	67.4	86.3
Provider availability	70.5	14.2	34.2	72.1	95.8
Provider appropriateness	70.3	7.6	50.4	70.9	85.5
Population ability to perceive	87.5	6.8	67.4	88.7	97.8
Population ability to reach	82	7.5	60.7	83.3	95
Population ability to engage	77.9	8.0	55.4	78.8	92.6
Other variables: proportion of registered population, % (2014-2022)					
Female	50.6	5.8	35.5	50.8	63.4
Age 24 or below	9.8	5.7	0.0	9.1	26.7
Age 25 to 34	13.7	7.8	1.6	12.2	38.6
Age 35 to 44	13.7	6.7	1.7	13.1	31.7
Age 45 to 54	14.4	6.5	1.7	14.5	28.5
Age 55 to 64	12.6	5.5	1.7	12.6	24.9
Age 65 to 74	11.3	5.3	1.4	11	24.5
Age 75 or above	10.2	4.4	1.0	10.1	21.4
White	82.7	22	8.9	92.6	100
Mixed	1.4	2.0	0.0	0.7	8.6
Asian	9.5	15.5	0.0	3.3	76.1
Black	3.6	6.5	0.0	0.9	31.4
Other ethnicities	2.9	4.5	0.0	1.1	19.6
Christian	54.4	13.9	7.7	56.4	79.7
Hindu	2.1	5.5	0.0	0	27.3
Jewish	0.5	3.1	0.0	0	9.6
No religion	30	11.2	1.7	30.9	54.1
Fulltime worker	44.2	8.6	23.6	44.1	65.6
Part-time worker	13.4	4.2	4.8	13.2	24.4
Student	4.0	5.0	0.0	3.1	18.5
Unemployed	5.1	4.5	0.0	3.9	19.5
Disabled	4.4	3.3	0.0	3.7	15
Smoker	42.5	8.8	18.8	42.8	62.4
With long-term conditions	52.9	8.3	32.1	53.3	70.9
Asthma	6.1	1.4	2.9	6.2	9.4
Cancer	2.8	1.2	0.6	2.8	5.8
Coronary heart disease	3.2	1.1	0.8	3.2	5.9
Chronic kidney disease	3.3	1.7	0.5	3.1	8.2
Chronic obstructive pulmonary disease	2.0	0.9	0.3	1.9	4.7
Dementia	0.7	0.4	0.1	0.7	2.0
Depression	8.2	3.6	1.6	7.8	18.3
Diabetes mellitus	5.8	1.6	2.2	5.8	10.8
Epilepsy	0.6	0.3	0.2	0.6	1.2
Heart Failure	0.9	0.4	0.2	0.8	2.2
Hypertension	14.4	3.7	5.1	14.5	23.2
Learning disability	0.5	0.3	0.1	0.5	1.4
Mental health	1.0	0.4	0.4	0.9	2.3
Obesity	8.0	3.1	2.2	7.7	16.5
Osteoporosis	0.2	0.3	0.0	0.1	1.3
Peripheral arterial disease	0.6	0.3	0.1	0.6	1.5
Palliative care	0.4	0.4	0.0	0.3	2.0
Rheumatoid arthritis	0.6	0.2	0.2	0.6	1.3
Other variables					
List size	8610	5375	1942	7609	26805
NHS primary care need index, 2019	1.0	0.1	0.8	1.0	1.2
Index of multiple deprivation (IMD)	23.6	11.6	6.1	21.7	54.9

Notes: SD, Standard deviation. 1st %, first percentile. 99th %, 99th percentile. PCN, Primary Care Network. * Negative payment may occur where there has been an overpayment in a previous period and money has subsequently been recovered (NHS England, 2022a). Payment was adjusted using the Consumer Price Index 2022 (Bank of England, 2022).

Table A3. Descriptive statistics across quintiles of need, deprivation, and practice size

Variables / Mean	Need					Deprivation					Size				
	Q1 Least	Q2	Q3	Q4	Q5 Most	Q1 Least	Q2	Q3	Q4	Q5 Most	Q1 Small	Q2	Q3	Q4	Q5 Large
Payment: per-patient payment, £ (2014-2022)															
Total payment	153.7	167.0	175.2	183.6	209.7	180.5	187.4	174.8	170.2	175.9	185.4	180.6	176.9	175.4	171.0
Capitation payment	94.3	98.5	101.2	104.0	109.6	95.8	99.4	100.4	103.6	108.5	105.4	102.7	101.2	100.6	97.8
Quality-based payment	11.3	13.1	14.3	15.4	17.1	13.9	14.7	14.3	13.9	14.4	14.3	14.2	14.2	14.5	14.1
Activity-based payment	11.9	13.3	14.4	15.0	16.2	13.8	14.0	14.1	13.7	15.2	13.8	13.8	14.2	14.5	14.5
Direct Enhanced Services (DES)	3.2	3.6	3.8	4.0	4.2	3.9	3.9	3.8	3.5	3.6	3.3	3.6	3.7	4.0	4.0
Local Incentive Schemes (LIS)	7.8	8.8	9.6	10.1	11.0	9.0	9.1	9.4	9.1	10.6	9.6	9.2	9.5	9.5	9.4
Non-DES	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1
PCN Participation	1.6	1.8	1.9	1.9	2.1	1.8	1.8	1.8	1.8	1.9	1.8	1.9	1.9	1.9	1.8
Winter Access Fund	0.6	0.7	0.8	0.7	0.6	0.6	0.6	0.6	1.0	0.7	1.0	0.8	0.7	0.6	0.6
Others	36.2	42.2	45.3	49.2	66.8	57.1	59.4	46.0	39.1	37.8	52.0	49.9	47.4	45.9	44.6
Operational payment	27.4	29.0	28.9	30.0	31.8	27.2	28.4	28.3	30.1	33.1	28.9	28.4	28.7	30.0	31.0
Dispensing and prescribing related payment	8.8	13.2	16.4	19.2	35.0	29.8	31.0	17.6	9.0	4.7	23.1	21.5	18.7	15.9	13.6
Dispensing fee	1.0	2.0	2.7	3.3	7.1	5.8	6.2	3.0	1.0	0.0	4.5	3.9	3.2	2.5	1.9
Prescribing fee	0.6	0.6	0.7	0.7	0.6	0.5	0.6	0.7	0.7	0.7	0.6	0.6	0.6	0.7	0.7
Reimbursement of drugs	7.2	10.6	13.0	15.2	27.3	23.5	24.3	14.0	7.3	3.9	17.9	17.0	14.8	12.7	11.0
Outcomes: proportion of positive experience, % (2015-2023)															
Overall experience	79.0	80.2	81.4	82.0	83.7	85.1	83.4	80.6	79.3	77.9	82.9	81.8	81.1	80.9	79.8
Provider approachability	65.1	65.3	66.0	66.1	68.4	69.0	67.7	65.6	64.6	63.9	69.8	68.6	66.2	64.4	62.1
Provider availability	69.2	69.3	70.3	70.7	72.9	73.5	72.5	69.8	69.0	67.5	75.4	71.9	69.7	68.5	67.1
Provider appropriateness	68.5	69.6	70.4	71.0	71.9	72.3	71.3	69.8	69.0	69.0	70.6	70.2	70.3	70.4	69.9
Population ability to perceive	86.7	87.3	87.6	87.5	88.1	91.1	89.5	87.4	85.6	83.5	87.0	87.0	87.4	87.9	88.0
Population ability to reach	82.0	82.0	81.8	82.1	82.2	81.7	81.5	81.7	82.2	83.0	83.3	82.8	82.0	81.4	80.6
Population ability to engage	76.4	77.4	77.9	78.5	79.4	80.1	79.1	77.4	76.7	76.2	77.3	77.9	78.0	78.3	78.1
											82.9	81.8	81.1	80.9	79.8
Other variables: proportion of registered population, % (2014-2022)															
Female	50.0	50.8	50.7	50.7	50.9	52.1	51.7	50.8	50.0	48.3	48.9	50.2	50.9	51.3	51.6
Age 24 or below	10.9	9.9	9.7	9.6	8.8	8.3	8.9	9.5	10.4	11.8	10.0	10.0	9.7	9.3	9.8
Age 25 to 34	16.6	14.4	13.5	12.8	11.4	11.3	12.5	13.9	15.3	15.9	14.3	14.0	13.6	13.3	13.6
Age 35 to 44	16.2	14.4	13.5	12.9	11.6	13.0	12.9	13.6	14.3	14.9	14.1	14.0	13.7	13.3	13.6
Age 45 to 54	14.7	14.5	14.5	14.3	13.8	14.4	14.1	14.0	14.3	15.0	14.9	14.6	14.3	14.0	14.1
Age 55 to 64	12.0	12.4	12.7	12.9	13.0	12.7	12.6	12.3	12.4	13.0	13.2	12.8	12.5	12.3	12.3
Age 65 to 74	10.1	10.8	11.3	11.7	12.4	11.7	11.7	11.1	10.7	11.1	11.6	11.3	11.1	11.1	11.1

Age 75 or above	7.0	9.1	10.2	11.1	13.3	12.2	11.7	10.1	8.7	8.1	9.9	9.8	10.2	10.6	10.4
White	70.2	78.8	84.1	87.9	92.4	92.7	89.6	82.7	75.8	72.1	78.3	79.3	82.1	86.3	87.2
Mixed	2.0	1.7	1.4	1.2	0.9	1.0	1.2	1.5	1.8	1.6	1.4	1.5	1.5	1.4	1.4
Asian	18.6	11.4	8.1	5.8	3.4	4.3	6.0	9.5	11.9	15.7	12.3	11.5	9.8	7.1	6.7
Black	4.8	4.7	3.8	2.9	1.8	0.8	1.5	3.4	6.4	6.0	4.3	4.4	3.8	2.9	2.6
Other ethnicities	4.5	3.5	2.7	2.2	1.4	1.1	1.7	2.9	4.1	4.5	3.7	3.4	2.9	2.3	2.1
Christian	45.9	51.8	55.5	58.0	60.9	57.5	56.5	54.2	52.5	51.3	54.6	53.6	54.0	55.5	54.4
Hindu	4.8	2.4	1.6	1.1	0.6	1.3	2.1	3.0	2.7	1.4	2.7	2.4	2.2	1.6	1.5
Jewish	1.1	0.8	0.4	0.2	0.1	0.7	0.8	0.4	0.4	0.2	0.4	0.6	0.7	0.4	0.5
No religion	28.3	29.9	30.4	30.8	30.8	33.9	32.5	30.6	28.3	24.9	26.3	28.2	30.0	31.9	33.6
Fulltime worker	49.0	46.2	44.4	42.1	39.1	45.7	45.4	45.8	44.5	39.4	42.5	43.5	44.2	45.0	45.6
Part-time worker	13.6	13.7	13.5	13.2	13.1	14.1	13.6	13.2	13.2	13.1	13.1	13.5	13.6	13.5	13.5
Student	5.6	4.4	3.8	3.6	2.9	3.3	3.6	3.9	4.5	5.0	4.0	4.2	4.0	3.7	4.4
Unemployed	5.1	5.0	5.0	5.3	5.0	2.2	3.0	4.5	6.4	9.3	6.3	5.6	5.0	4.4	4.0
Disabled	3.0	3.8	4.5	5.3	5.6	2.3	3.2	4.1	5.3	7.4	5.2	4.6	4.4	4.1	3.8
Smoker	37.5	40.9	42.9	44.8	46.8	39.6	41.9	42.8	43.2	45.4	43.6	42.2	42.2	42.7	42.2
With long-term conditions	46.7	50.7	53.3	55.7	58.1	51.3	52.8	53.0	52.8	54.7	53.3	52.7	52.8	53.1	52.7
Asthma	5.4	5.9	6.2	6.4	6.7	6.1	6.2	6.0	6.0	6.3	6.0	6.1	6.1	6.2	6.2
Cancer	2.1	2.6	2.9	3.0	3.5	3.5	3.3	2.8	2.4	2.2	2.5	2.7	2.9	3.0	3.0
Coronary heart disease	2.2	2.8	3.2	3.6	4.2	3.1	3.3	3.2	3.1	3.3	3.3	3.2	3.2	3.3	3.1
Chronic kidney disease	2.2	2.9	3.3	3.7	4.4	3.4	3.6	3.4	3.1	3.1	3.2	3.3	3.3	3.4	3.3
Chronic obstructive pulmonary disease	1.2	1.6	2.0	2.4	2.7	1.5	1.8	1.9	2.1	2.6	2.1	2.0	2.0	2.0	1.8
Dementia	0.5	0.7	0.7	0.8	1.0	0.8	0.8	0.8	0.7	0.6	0.7	0.7	0.7	0.8	0.8
Depression	6.8	7.7	8.5	9.0	9.2	7.4	8.0	8.3	8.3	9.1	7.8	8.0	8.2	8.5	8.6
Diabetes mellitus	5.2	5.5	5.9	6.1	6.5	4.8	5.6	6.0	6.3	6.7	6.3	6.1	5.8	5.7	5.4
Epilepsy	0.5	0.6	0.7	0.7	0.8	0.6	0.6	0.6	0.7	0.7	0.6	0.6	0.7	0.7	0.6
Heart Failure	0.6	0.8	0.9	1.0	1.1	0.8	0.9	0.9	0.8	0.9	0.8	0.8	0.9	0.9	0.9
Hypertension	11.5	13.3	14.5	15.4	17.3	14.6	15.1	14.6	14.0	13.7	14.8	14.4	14.3	14.5	14.0
Learning disability	0.4	0.5	0.5	0.6	0.6	0.4	0.5	0.5	0.6	0.7	0.5	0.5	0.5	0.5	0.5
Mental health	0.9	0.9	1.0	1.0	1.1	0.7	0.8	1.0	1.1	1.2	1.0	1.0	1.0	0.9	0.9
Obesity	6.3	7.4	8.1	8.8	9.4	6.3	7.5	8.2	8.7	9.4	8.4	8.2	8.0	7.9	7.5
Osteoporosis	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3
Peripheral arterial disease	0.4	0.5	0.6	0.7	0.8	0.5	0.6	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.6
Palliative care	0.3	0.4	0.4	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Rheumatoid arthritis	0.5	0.6	0.6	0.7	0.8	0.6	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Other variables															
List size	9,074	9,313	8,868	8,346	7,446	9,644	9,261	8,854	8,267	6,990	3,241	5,426	7,647	10,318	16,188
NHS primary care need index	0.9	1.0	1.0	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Index of multiple deprivation (IMD)	18.1	20.7	23.4	27.0	28.5	9.9	15.7	21.8	29.0	41.8	27.4	25.2	23.5	21.7	20.0

Notes: SD, Standard deviation. 1st %, first percentile. 99th %, 99th percentile. PCN, Primary Care Network. Payment was adjusted using the Consumer Price Index: Bank of England. Inflation calculator 2022; Available from: https://www.bankofengland.co.uk/monetary-policy/inflation/inflation-calculator.

Table A4. Associations between lagged per-patient payment, in total and by types, and access outcomes

(a) Total payments

	(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall
Total payments	0.018***	0.024***	0.005	0.007***	0.012***	0.012***	0.029***
	(0.007)	(0.008)	(0.004)	(0.002)	(0.004)	(0.004)	(0.006)
Adjusted R-squared	0.741	0.705	0.569	0.680	0.582	0.487	0.666
Outcome mean	0.662	0.705	0.703	0.875	0.82	0.779	0.813

(b) Payment types

	(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall
Capitation	-0.007	-0.014***	-0.002	-0.002	0.006**	0.001	-0.003
	(0.004)	(0.005)	(0.003)	(0.002)	(0.003)	(0.003)	(0.004)
Quality-based	0.007*	0.002	0.013***	0.008***	0.004	0.009***	0.012***
	(0.004)	(0.004)	(0.003)	(0.002)	(0.002)	(0.003)	(0.004)
Activity-based	0.004***	0.003***	0.0000	-0.001***	0.000	-0.000	0.003***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
Others	0.005***	0.008***	0.002*	0.002***	0.002**	0.004***	0.008***
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Adjusted R-squared	0.777	0.745	0.628	0.724	0.639	0.557	0.712
Outcome mean	0.662	0.705	0.703	0.875	0.82	0.779	0.813

Notes: Each column reports estimate from separate regression models with 55,415 practice-year observations (7,445 unique practices). The coefficients represent the percentage change in outcomes associated with a 1% increase in payment per patient. Standard errors clustered at the practice level. A */**/*** indicates significant at the 10/5/1% levels.

Table A5. Heterogeneous effects across need, TWFE

(1) Need quintile 1 (Lowest need)

	(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	0.004	0.025	0.003	0.004	0.001	0.025***	0.030**							
	(0.014)	(0.017)	(0.009)	(0.006)	(0.007)	(0.009)	(0.013)							
Capitation								-0.019**	-0.021**	0.001	0.002	-0.001	0.005	-0.001
								(0.009)	(0.009)	(0.005)	(0.004)	(0.007)	(0.008)	(0.007)
Quality-based								0.017***	0.004	0.019***	0.015***	0.010**	0.008	0.019***
								(0.007)	(0.007)	(0.006)	(0.003)	(0.004)	(0.006)	(0.007)
Activity-based								-0.001	-0.003	-0.003*	-0.002**	-0.002*	0.000	0.001
								(0.002)	(0.003)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
Others								0.006	0.010**	0.002	0.001	0.001	0.004*	0.007**
								(0.004)	(0.005)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Observation	11,089	11,089	11,089	11,089	11,089	11,089	11,089	11,089	11,089	11,089	11,089	11,089	11,089	11,089
Adj. R-squared	0.719	0.692	0.528	0.683	0.609	0.518	0.672	0.710	0.681	0.524	0.672	0.607	0.515	0.666
Outcome mean	0.651	0.692	0.685	0.867	0.820	0.764	0.790	0.651	0.692	0.685	0.867	0.820	0.762	0.790

(2) Need quintile 2

	(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	0.022	0.034**	0.000	0.011**	0.019***	0.018*	0.036***							
	(0.015)	(0.017)	(0.009)	(0.005)	(0.007)	(0.009)	(0.013)							
Capitation								-0.006	-0.018*	-0.002	0.002	0.004	0.004	-0.001
								(0.009)	(0.009)	(0.005)	(0.004)	(0.003)	(0.007)	(0.007)
Quality-based								-0.002	0.002	0.014***	0.003	0.008	0.007	0.006
								(0.009)	(0.009)	(0.005)	(0.003)	(0.005)	(0.005)	(0.008)
Activity-based								0.006***	0.005**	-0.001	-0.001	0.002**	-0.001	0.004*
								(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Others								0.005	0.011**	0.002	0.003*	0.002	0.005*	0.012***
								(0.004)	(0.005)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Observation	11,138	11,138	11,138	11,138	11,138	11,138	11,138	11,138	11,138	11,138	11,138	11,138	11,138	11,138
Adj. R-squared	0.735	0.709	0.571	0.692	0.598	0.495	0.671	0.729	0.700	0.566	0.674	0.596	0.493	0.664
Outcome mean	0.653	0.693	0.696	0.873	0.820	0.774	0.802	0.652	0.693	0.696	0.873	0.820	0.773	0.802

(3) Need quintile 3

	(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	0.014	0.008	0.013	0.011*	0.009	0.018*	0.013							
	(0.017)	(0.021)	(0.008)	(0.005)	(0.008)	(0.009)	(0.017)							
Capitation								0.005	-0.007	0.003	0.008	0.014**	0.014*	0.014
								(0.011)	(0.011)	(0.006)	(0.006)	(0.006)	(0.007)	(0.010)
Quality-based								0.008	0.006	0.017***	0.009***	0.003	0.018***	0.020**
								(0.009)	(0.010)	(0.006)	(0.003)	(0.005)	(0.007)	(0.009)
Activity-based								0.001	0.003	0.001	-0.000	-0.001	0.001	0.001
								(0.002)	(0.003)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Others								0.004	0.004	0.004	0.004**	0.002	0.008***	0.004
								(0.005)	(0.006)	(0.003)	(0.002)	(0.002)	(0.003)	(0.004)
Observation	11,037	11,037	11,037	11,037	11,037	11,037	11,037	11,037	11,037	11,037	11,037	11,037	11,037	11,037
Adj. R-squared	0.747	0.702	0.570	0.682	0.593	0.495	0.650	0.739	0.695	0.565	0.669	0.589	0.493	0.643
Outcome mean	0.660	0.703	0.704	0.876	0.818	0.780	0.815	0.660	0.704	0.703	0.876	0.819	0.778	0.814

(4) Need quintile 4

	(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	0.027*	0.023	-0.004	-0.001	0.021***	0.000	0.029**							
	(0.014)	(0.017)	(0.010)	(0.005)	(0.007)	(0.009)	(0.013)							
Capitation								-0.016	-0.044**	-0.012	0.006	0.017*	0.001	-0.013
								(0.013)	(0.020)	(0.014)	(0.006)	(0.009)	(0.013)	(0.014)
Quality-based								0.004	0.004	0.014***	0.005	-0.006	0.009*	0.012
								(0.007)	(0.008)	(0.005)	(0.004)	(0.005)	(0.006)	(0.008)
Activity-based								0.007***	0.004	0.003	-0.000	-0.000	0.001	0.005**
								(0.003)	(0.003)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
Others								0.007	0.010*	<0.0001	0.002	0.007***	0.003	0.012***
								(0.004)	(0.005)	(0.003)	(0.002)	(0.002)	(0.003)	(0.004)
Observation	11,029	11,029	11,029	11,029	11,029	11,029	11,029	11,029	11,029	11,029	11,029	11,029	11,029	11,029
Adj. R-squared	0.744	0.716	0.575	0.679	0.553	0.441	0.661	0.740	0.711	0.573	0.664	0.547	0.438	0.654
Outcome mean	0.661	0.707	0.710	0.875	0.821	0.786	0.820	0.661	0.707	0.710	0.875	0.822	0.784	0.820

(5) Need quintile 5 (Highest Need)

	(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	0.023*	0.023	0.020***	0.009*	0.003	0.003	0.031***							
	(0.013)	(0.017)	(0.007)	(0.005)	(0.009)	(0.008)	(0.011)							
Capitation								-0.000	-0.011	0.005	0.007	0.012**	-0.003	0.006
								(0.009)	(0.010)	(0.006)	(0.005)	(0.005)	(0.006)	(0.007)
Quality-based								0.013	0.014	0.004	0.012***	0.005	0.004	0.021*
								(0.010)	(0.015)	(0.007)	(0.004)	(0.006)	(0.007)	(0.011)
Activity-based								0.004**	0.003	0.003***	0.001	-0.001	0.001	0.004***
								(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Others								0.011***	0.010**	0.005**	0.002	0.003	0.002	0.010***
								(0.004)	(0.005)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)
Observation	11,103	11,103	11,103	11,103	11,103	11,103	11,103	11,103	11,103	11,103	11,103	11,103	11,103	11,103
Adj. R-squared	0.767	0.712	0.589	0.671	0.560	0.461	0.670	0.763	0.708	0.587	0.657	0.555	0.458	0.665
Outcome mean	0.684	0.729	0.719	0.881	0.822	0.794	0.837	0.684	0.730	0.719	0.881	0.822	0.793	0.837

Notes: Each column reports estimate from separate regression models. The coefficients represent the percentage change in outcomes associated with a 1% increase in payment per patient. Standard errors clustered at the practice level. A */**/*** indicates significant at the 10/5/1% levels.

Table A6. Heterogeneous effects across deprivation, TWFE

(1) Deprivation quintile 1 (Least deprived)

	(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	0.021	0.029	0.005	0.001	0.015*	0.006	0.027**							
	(0.015)	(0.018)	(0.009)	(0.005)	(0.009)	(0.009)	(0.012)							
Capitation								-0.003	-0.005	-0.007	0.002	0.012***	-0.012	0.008
								(0.010)	(0.010)	(0.006)	(0.003)	(0.005)	(0.007)	(0.008)
Quality-based								0.014**	0.001	0.007	0.005**	0.002	-0.000	0.004
								(0.007)	(0.009)	(0.005)	(0.002)	(0.005)	(0.006)	(0.007)
Activity-based								0.005**	0.002	0.002**	0.001	0.002*	0.002	0.004**
								(0.002)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Others								0.006	0.009	0.001	-0.000	0.001	0.005*	0.007*
								(0.005)	(0.006)	(0.003)	(0.001)	(0.003)	(0.003)	(0.004)
Observation	11,211	11,211	11,211	11,211	11,211	11,211	11,211	11,211	11,211	11,211	11,211	11,211	11,211	11,211
Adj. R-squared	0.752	0.723	0.522	0.576	0.621	0.492	0.648	0.747	0.718	0.521	0.572	0.619	0.491	0.639
Outcome mean	0.690	0.735	0.723	0.911	0.817	0.801	0.851	0.690	0.736	0.723	0.912	0.817	0.801	0.851

(2) Deprivation quintile 2

	(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	0.046***	0.058***	0.017**	0.010**	0.013	0.022**	0.040***							
	(0.016)	(0.021)	(0.008)	(0.005)	(0.008)	(0.010)	(0.015)							
Capitation								0.011	-0.010	-0.001	0.003	0.014*	0.014**	0.012
								(0.008)	(0.011)	(0.005)	(0.004)	(0.008)	(0.007)	(0.009)
Quality-based								0.011	0.006	0.016***	0.005	<-0.0001	0.012	0.019**
								(0.009)	(0.012)	(0.006)	(0.004)	(0.006)	(0.007)	(0.009)
Activity-based								0.003	0.001	-0.001	0.001	0.001	-0.001	0.001
								(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Others								0.010**	0.019***	0.006**	0.004**	0.002	0.005*	0.012***
								(0.005)	(0.006)	(0.003)	(0.002)	(0.003)	(0.003)	(0.004)
Observation	11,134	11,134	11,134	11,134	11,134	11,134	11,134	11,134	11,134	11,134	11,134	11,134	11,134	11,134
Adj. R-squared	0.757	0.721	0.568	0.604	0.607	0.501	0.662	0.750	0.715	0.566	0.599	0.600	0.499	0.656
Outcome mean	0.677	0.725	0.713	0.895	0.815	0.791	0.834	0.677	0.725	0.713	0.896	0.815	0.791	0.834

(3) Deprivation quintile 3

	(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	-0.014	-0.009	-0.012	-0.003	0.013	0.013	0.003							
	(0.017)	(0.020)	(0.009)	(0.006)	(0.009)	(0.009)	(0.015)							
Capitation								-0.034***	-0.040***	-0.008	-0.004**	0.003	-0.011*	-0.018**
								(0.012)	(0.012)	(0.007)	(0.002)	(0.006)	(0.006)	(0.008)
Quality-based								0.014	0.014	0.020***	0.013***	0.011**	0.012**	0.018**
								(0.009)	(0.010)	(0.006)	(0.004)	(0.005)	(0.006)	(0.008)
Activity-based								0.002	<0.0001	-0.002	-0.000	-0.001	-0.002	0.002
								(0.002)	(0.003)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Others								-0.002	<0.0001	-0.001	0.001	0.004*	0.006**	0.005
								(0.004)	(0.005)	(0.002)	(0.002)	(0.002)	(0.003)	(0.004)
Observation	11,071	11,071	11,071	11,071	11,071	11,071	11,071	11,071	11,071	11,071	11,071	11,071	11,071	11,071
Adj. R-squared	0.725	0.684	0.566	0.639	0.577	0.484	0.646	0.718	0.676	0.561	0.632	0.571	0.480	0.640
Outcome mean	0.656	0.698	0.698	0.874	0.817	0.774	0.806	0.656	0.699	0.698	0.874	0.818	0.774	0.806

(4) Deprivation quintile 4

	(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	0.015	0.021	0.004	0.013**	0.008	0.011	0.029**							
	(0.013)	(0.016)	(0.009)	(0.005)	(0.007)	(0.009)	(0.013)							
Capitation								-0.011	-0.030**	-0.001	0.009*	0.026***	0.015**	-0.005
								(0.012)	(0.012)	(0.009)	(0.005)	(0.008)	(0.007)	(0.011)
Quality-based								-0.006	-0.006	0.007	-0.001	0.005	0.011*	0.005
								(0.010)	(0.010)	(0.006)	(0.003)	(0.005)	(0.006)	(0.009)
Activity-based								0.001	0.003	<0.0001	0.001	<0.0001	-0.000	0.005**
								(0.002)	(0.003)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Others								0.008**	0.009**	0.003	0.004***	0.002	0.004	0.009***
								(0.004)	(0.005)	(0.002)	(0.001)	(0.002)	(0.003)	(0.003)
Observation	11,031	11,031	11,031	11,031	11,031	11,031	11,031	11,031	11,031	11,031	11,031	11,031	11,031	11,031
Adj. R-squared	0.721	0.687	0.557	0.653	0.566	0.465	0.657	0.712	0.676	0.550	0.647	0.558	0.463	0.651
Outcome mean	0.646	0.690	0.690	0.856	0.822	0.767	0.793	0.646	0.690	0.690	0.856	0.823	0.766	0.793

(5) Deprivation quintile 5 (Most deprived)

	(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	0.028**	0.026*	0.012	0.011**	0.009	0.005	0.042***							
	(0.013)	(0.015)	(0.008)	(0.005)	(0.006)	(0.008)	(0.012)							
Capitation								-0.000	-0.004	-0.001	0.008	0.008*	0.001	0.017
								(0.010)	(0.013)	(0.006)	(0.005)	(0.004)	(0.007)	(0.011)
Quality-based								0.015**	0.020**	0.016***	0.002	0.001	0.006	0.013
								(0.008)	(0.010)	(0.005)	(0.004)	(0.006)	(0.005)	(0.008)
Activity-based								0.004	0.003	0.002	-0.000	-0.001	0.000	0.004*
								(0.003)	(0.003)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
Others								0.010***	0.011**	0.005**	0.005***	0.004**	0.005**	0.014***
								(0.003)	(0.004)	(0.002)	(0.001)	(0.002)	(0.002)	(0.003)
Observation	10,968	10,968	10,968	10,968	10,968	10,968	10,968	10,968	10,968	10,968	10,968	10,968	10,968	10,968
Adj. R-squared	0.722	0.682	0.580	0.665	0.531	0.441	0.656	0.714	0.672	0.575	0.655	0.526	0.436	0.648
Outcome mean	0.639	0.675	0.690	0.835	0.830	0.762	0.779	0.639	0.676	0.689	0.835	0.830	0.761	0.778

Notes: Each column reports estimate from separate regression models. The coefficients represent the percentage change in outcomes associated with a 1% increase in payment per patient. Standard errors clustered at the practice level. A */**/*** indicates significant at the 10/5/1% levels.

Table A7. Heterogeneous effects across list size, TWFE

(1) List size quintile 1 (Smallest)

	(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	0.014	0.017	0.025***	0.007	0.007	0.020***	0.023**							
	(0.012)	(0.013)	(0.007)	(0.005)	(0.006)	(0.007)	(0.011)							
Capitation								0.001	-0.004	0.003	0.002	0.009*	0.005	0.004
								(0.009)	(0.007)	(0.004)	(0.004)	(0.005)	(0.004)	(0.006)
Quality-based								0.013**	0.018***	0.007	0.005*	0.002	0.005	0.017***
								(0.005)	(0.006)	(0.005)	(0.003)	(0.004)	(0.005)	(0.005)
Activity-based								-0.000	-0.000	0.001	0.000	0.001	0.000	0.001
								(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Others								0.008***	0.010***	0.008***	0.003*	0.004***	0.006***	0.007***
								(0.003)	(0.003)	(0.002)	(0.001)	(0.002)	(0.002)	(0.003)
Observation	10,801	10,801	10,801	10,801	10,801	10,801	10,801	10,801	10,801	10,801	10,801	10,801	10,801	10,801
Adj. R-squared	0.681	0.693	0.583	0.696	0.532	0.527	0.661	0.673	0.685	0.578	0.683	0.529	0.524	0.653
Outcome mean	0.698	0.754	0.706	0.870	0.833	0.773	0.829	0.697	0.754	0.706	0.870	0.834	0.771	0.828

(2) List size quintile 2

	(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	0.012	0.024*	0.001	0.005	0.011*	0.006	0.027**							
	(0.012)	(0.014)	(0.008)	(0.005)	(0.006)	(0.008)	(0.012)							
Capitation								-0.000	-0.000	-0.003	0.003	0.010***	-0.006	0.007
								(0.008)	(0.010)	(0.006)	(0.004)	(0.003)	(0.007)	(0.008)
Quality-based								0.003	-0.008	0.008	0.005	0.006	0.006	0.009
								(0.008)	(0.008)	(0.005)	(0.003)	(0.004)	(0.005)	(0.006)
Activity-based								-0.001	-0.001	-0.002	-0.000	0.000	-0.001	0.001
								(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Others								0.013***	0.017***	0.005**	0.004**	0.002	0.004*	0.014***
								(0.003)	(0.004)	(0.002)	(0.001)	(0.002)	(0.002)	(0.003)
Observation	11,060	11,060	11,060	11,060	11,060	11,060	11,060	11,060	11,060	11,060	11,060	11,060	11,060	11,060
Adj. R-squared	0.710	0.691	0.596	0.703	0.545	0.514	0.674	0.701	0.681	0.591	0.689	0.540	0.511	0.665
Outcome mean	0.686	0.719	0.702	0.870	0.828	0.779	0.818	0.685	0.719	0.702	0.870	0.828	0.778	0.817

(3) List size quintile 3

	(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	0.009	0.000	0.006	0.005	0.019***	0.008	0.007							
	(0.016)	(0.016)	(0.008)	(0.004)	(0.007)	(0.008)	(0.013)							
Capitation								-0.001	-0.023	-0.001	0.006	0.024***	-0.001	0.004
								(0.010)	(0.014)	(0.005)	(0.006)	(0.006)	(0.006)	(0.007)
Quality-based								0.038***	0.045***	0.018***	0.011***	0.003	0.011*	0.036***
								(0.008)	(0.011)	(0.006)	(0.004)	(0.004)	(0.006)	(0.009)
Activity-based								0.000	-0.001	0.002*	-0.000	0.002**	0.002	0.002
								(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Others								0.006*	0.007	0.000	0.002	0.005**	0.004*	0.005
								(0.004)	(0.004)	(0.002)	(0.001)	(0.002)	(0.002)	(0.003)
Observation	11,132	11,132	11,132	11,132	11,132	11,132	11,132	11,132	11,132	11,132	11,132	11,132	11,132	11,132
Adj. R-squared	0.723	0.693	0.585	0.707	0.564	0.508	0.672	0.717	0.685	0.580	0.690	0.558	0.507	0.664
Outcome mean	0.662	0.697	0.703	0.874	0.820	0.780	0.811	0.662	0.696	0.703	0.874	0.820	0.780	0.810

(4) List size quintile 4

	(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	0.016	0.022	0.008	0.007	-0.002	0.001	0.039***							
	(0.014)	(0.018)	(0.009)	(0.006)	(0.008)	(0.009)	(0.014)							
Capitation								-0.013	-0.030**	0.008	0.017*	0.006	0.009	0.006
								(0.012)	(0.013)	(0.008)	(0.010)	(0.006)	(0.010)	(0.015)
Quality-based								-0.004	-0.005	0.022***	0.008**	0.000	0.010	0.010
								(0.009)	(0.009)	(0.007)	(0.003)	(0.005)	(0.006)	(0.009)
Activity-based								0.002	0.002	-0.000	-0.000	-0.000	-0.001	0.002
								(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Others								0.007*	0.009*	0.004	0.003**	0.002	0.004	0.013***
								(0.004)	(0.005)	(0.002)	(0.001)	(0.002)	(0.003)	(0.004)
Observation	11,206	11,206	11,206	11,206	11,206	11,206	11,206	11,206	11,206	11,206	11,206	11,206	11,206	11,206
Adj. R-squared	0.741	0.714	0.587	0.683	0.577	0.487	0.682	0.736	0.707	0.583	0.672	0.571	0.484	0.673
Outcome mean	0.644	0.685	0.704	0.879	0.814	0.783	0.809	0.644	0.685	0.704	0.879	0.815	0.783	0.809

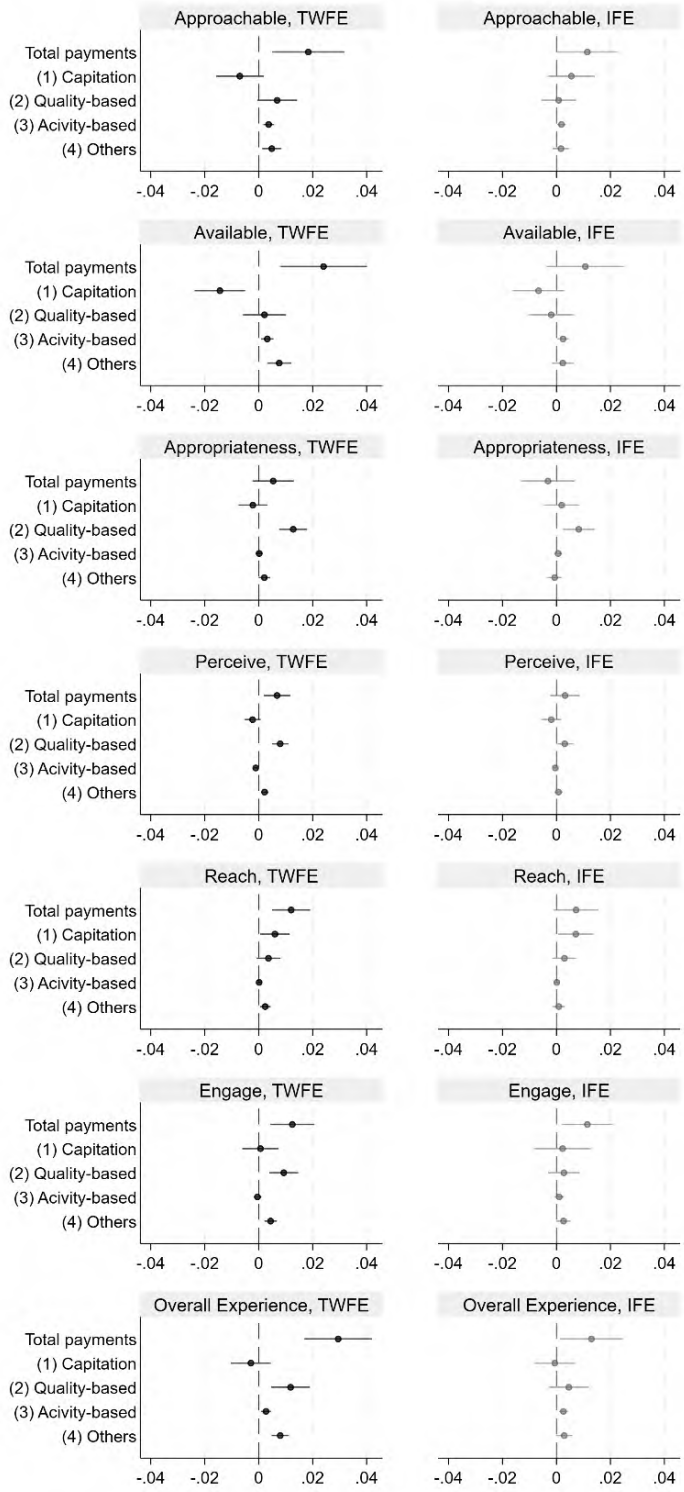
(5) List size quintile 5 (Largest)

	(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	0.043***	0.049***	-0.006	0.002	0.020**	0.016*	0.042***							
	(0.014)	(0.018)	(0.008)	(0.005)	(0.008)	(0.009)	(0.013)							
Capitation								-0.021**	-0.032***	-0.011	-0.002	0.010	0.000	-0.004
								(0.010)	(0.011)	(0.007)	(0.003)	(0.008)	(0.006)	(0.007)
Quality-based								0.013*	0.005	0.017***	0.012***	0.005	0.014**	0.014*
								(0.007)	(0.008)	(0.005)	(0.004)	(0.005)	(0.005)	(0.007)
Activity-based								0.004*	0.003	-0.001	-0.001	-0.001	-0.001	0.004
								(0.003)	(0.003)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
Others								0.007*	0.012**	0.001	0.001	0.004*	0.005*	0.011***
								(0.004)	(0.005)	(0.002)	(0.002)	(0.002)	(0.003)	(0.004)
Observation	11,216	11,216	11,216	11,216	11,216	11,216	11,216	11,216	11,216	11,216	11,216	11,216	11,216	11,216
Adj. R-squared	0.750	0.711	0.543	0.654	0.611	0.466	0.664	0.744	0.706	0.540	0.644	0.606	0.466	0.660
Outcome mean	0.621	0.671	0.699	0.880	0.806	0.781	0.798	0.620	0.671	0.699	0.879	0.807	0.780	0.797

Notes: Each column reports estimate from separate regression models. The coefficients represent the percentage change in outcomes associated with a 1% increase in payment per patient. Standard errors clustered at the practice level. A */**/*** indicates significant at the 10/5/1% levels.

Appendix B: Sensitivity analysis using Interactive fixed effects adjusted model

Figure B1. Associations between lagged per-patient payment, in total and by types, and access outcomes, TWFE and IFE-adjusted model



Notes: The figure presents coefficients with 95% confident interval. The coefficients represent the percentage change in outcomes associated with a 1% increase in per-patient payment. CI, Confidence interval; TWFE, Two-way fixed effects estimation; IFE, Interactive fixed effects estimation.

Table B1. Associations between lagged per-patient payment, in total and by types, and access outcomes, IFE-adjusted model

(a) Total payments

	(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall
Total payments	0.011**	0.011	-0.003	0.003	0.007**	0.011**	0.013**
	(0.006)	(0.007)	(0.005)	(0.003)	(0.004)	(0.005)	(0.006)
Outcome mean	0.662	0.705	0.703	0.875	0.82	0.779	0.813

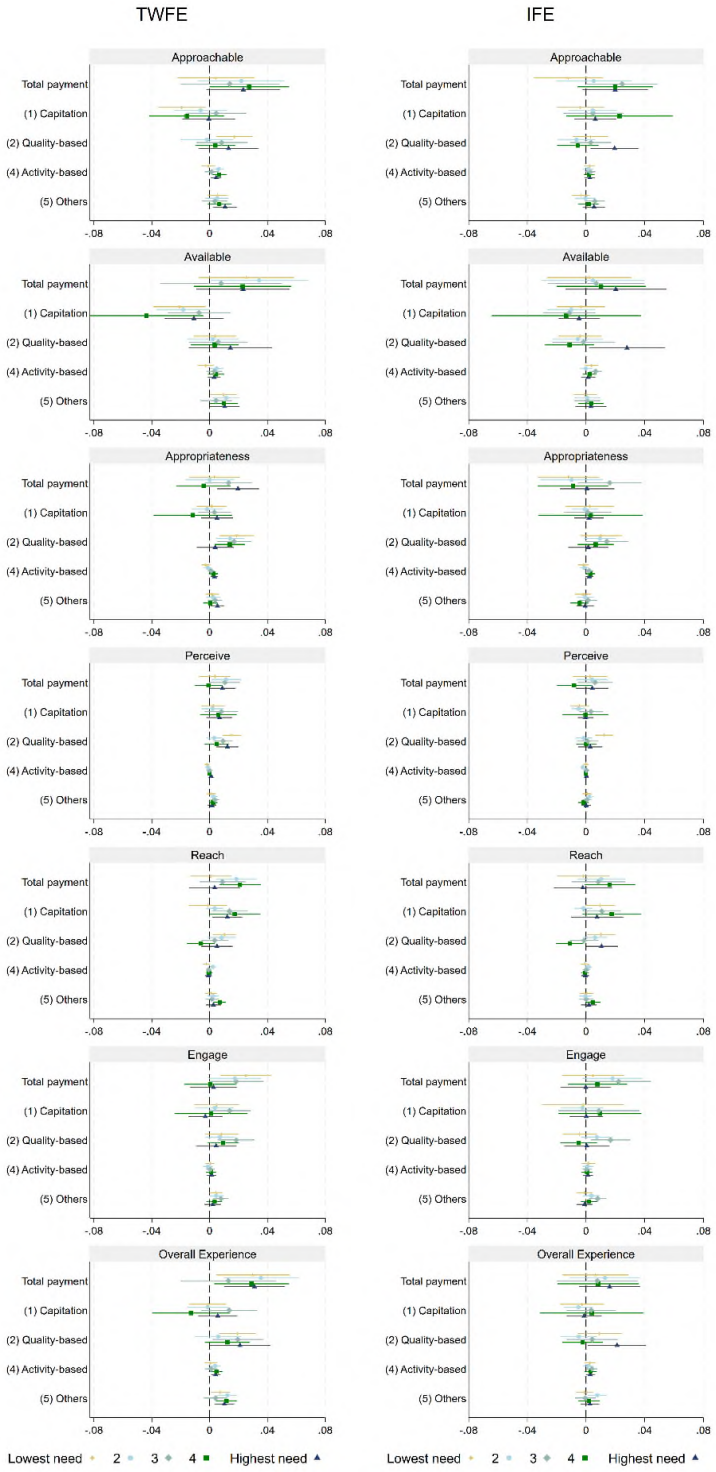
(b) Payment types

	(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall
Capitation	0.006	-0.007	0.002	-0.002	0.001**	0.002	-0.001
	(0.004)	(0.005)	(0.003)	(0.002)	(0.003)	(0.005)	(0.004)
Quality-based	0.001	-0.002	0.008**	0.003*	0.003	0.003	0.004
	(0.003)	(0.004)	0.003	0.002	(0.002)	(0.003)	(0.004)
Activity-based	0.002**	0.002**	0.001	-0.0004	0.0001	0.001	0.003***
	(0.001)	(0.001)	(0.001)	(0.0004)	(0.0001)	(0.001)	(0.001)
Others	0.002	0.002	-0.001	0.001	0.001	0.004**	0.003**
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Outcome mean	0.662	0.705	0.703	0.875	0.82	0.779	0.813

Notes: Each column reports estimate from separate regression models with 55,415 practice-year observations (7,445 unique practices). The coefficients represent the percentage change in outcomes associated with a 1% increase in payment per patient. Standard errors clustered at the practice level. A */**/*** indicates significant at the 10/5/1% levels. The IFE-adjusted model specifies one factor, selected using the eigenvalue ratio estimator.

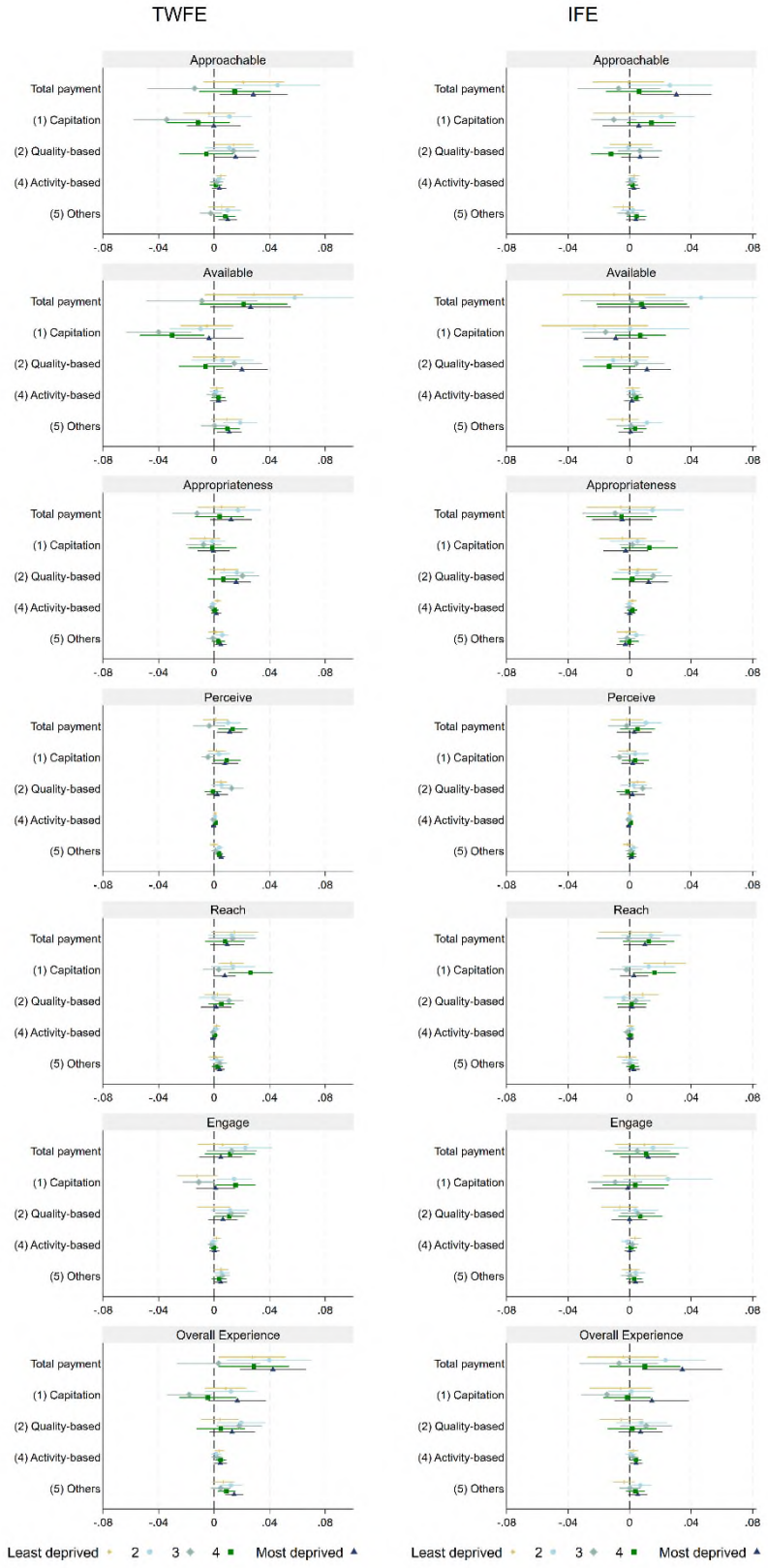
Figure B2. Heterogeneous effects across need, deprivation, and list size, IFE-adjusted model

(a) Heterogeneity by need



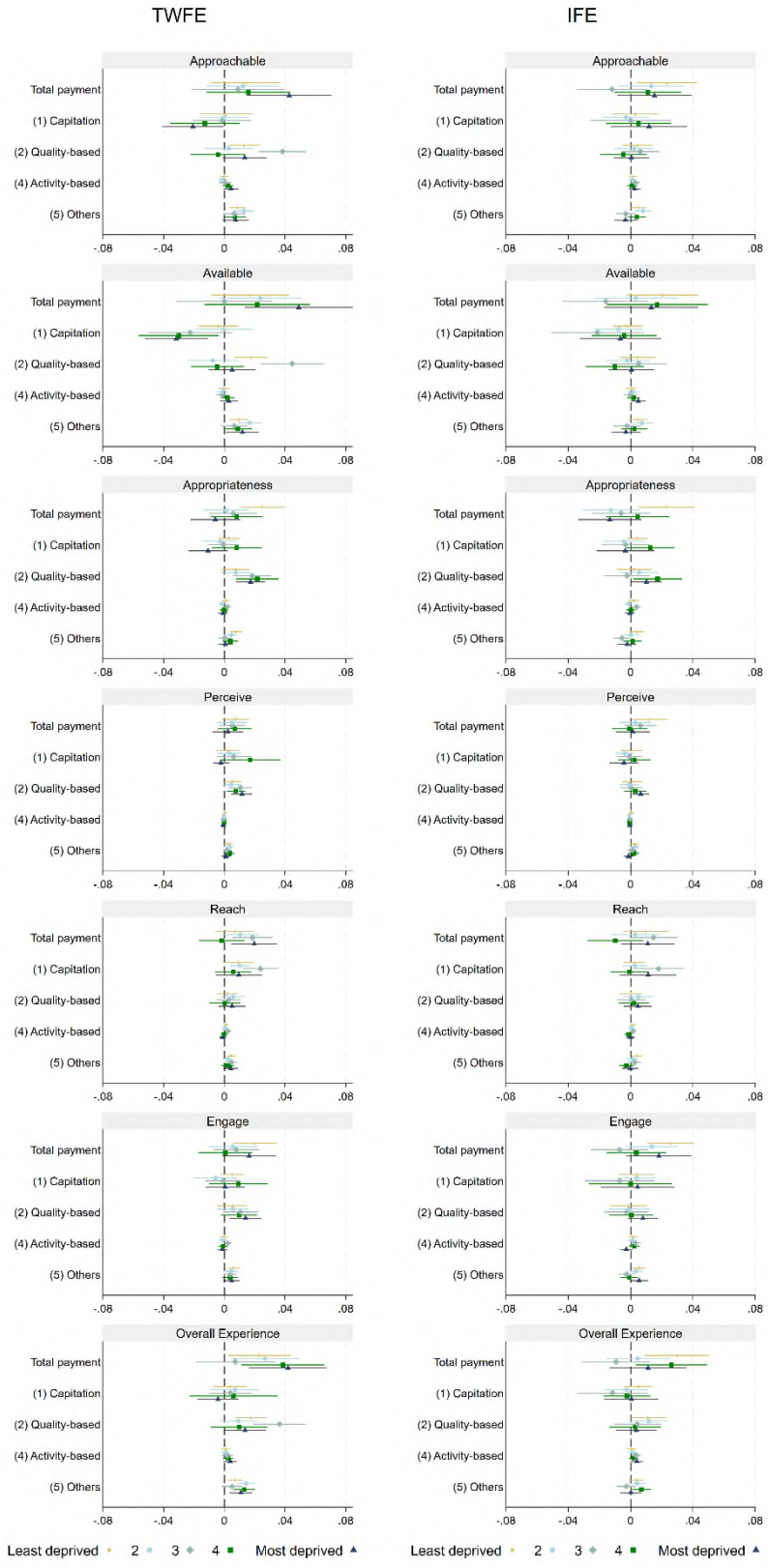
Notes: The figure presents coefficients with 95% confident interval. The coefficients represent the percentage change in outcomes associated with a 1% increase in per-patient payment in total and by type across quintiles of need. TWFE, two-way fixe effects. IFE, interactive fixed effects. The IFE-adjusted model specifies one factor, selected using the eigenvalue ratio estimator.

(b) Heterogeneity by deprivation



Notes: The figure presents coefficients with 95% confident interval. The coefficients represent the percentage change in outcomes associated with a 1% increase in per-patient payment in total and by type across quintiles of deprivation. TWFE, two-way fixe effects. IFE, interactive fixed effects. The IFE-adjusted model specifies one factor, selected using the eigenvalue ratio estimator.

(c) Heterogeneity by list size



Notes: The figure presents coefficients with 95% confident interval. The coefficients represent the percentage change in outcomes associated with a 1% increase in per-patient payment in total and by type across quintiles of list size. TWFE, two-way fixe effects. IFE, interactive fixed effects. The IFE-adjusted model specifies one factor, selected using the eigenvalue ratio estimator.

Table B2. Heterogeneous effects across need, IFE

(1) Need quintile 1 (Least need)

		(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	coef.	-0.012	0.002	-0.012	0.003	-0.002	0.005	0.007							
	stderr.	0.012	0.015	0.011	0.006	0.009	0.011	0.011							
Capitation	coef.								-0.004	-0.003	0.003	-0.004	0.010*	-0.002	-0.003
	stderr.								0.008	0.008	0.009	0.003	0.005	0.014	0.008
Quality-based	coef.								0.003	-0.004	0.010	0.012***	0.010**	-0.004	0.009
	stderr.								0.006	0.008	0.007	0.003	0.005	0.006	0.008
Activity-based	coef.								0.002	0.004	-0.002	0.000	-0.001	0.002	0.003
	stderr.								0.002	0.002	0.002	0.001	0.002	0.002	0.002
Others	coef.								-0.003	-0.001	-0.002	0.001	0.000	-0.001	-0.001
	stderr.								0.003	0.004	0.003	0.002	0.002	0.003	0.003
Observation		11,089	11,089	11,089	11,089	11,089	11,089	11,089	11,089	11,089	11,089	11,089	11,089	11,089	11,089
Outcome mean		0.651	0.692	0.685	0.867	0.820	0.764	0.790	0.651	0.692	0.685	0.867	0.820	0.762	0.790

(2) Need quintile 2

		(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	coef.	0.005	0.005	-0.010	0.004	0.010	0.018*	0.013							
	stderr.	0.013	0.018	0.011	0.005	0.008	0.010	0.012							
Capitation	coef.								0.005	-0.010	-0.001	-0.005**	-0.002	-0.003	-0.005
	stderr.								0.008	0.008	0.005	0.002	0.003	0.007	0.005
Quality-based	coef.								-0.006	-0.006	0.009*	-0.002	0.006	0.007	-0.005
	stderr.								0.007	0.009	0.006	0.003	0.004	0.006	0.006
Activity-based	coef.								0.001	0.000	-0.001	-0.002	0.002***	0.001	0.001
	stderr.								0.002	0.002	0.001	0.001	0.001	0.002	0.002
Others	coef.								0.000	0.001	0.000	0.002	0.000	0.004	0.008**
	stderr.								0.004	0.005	0.003	0.002	0.002	0.003	0.003
Observation		11,138	11,138	11,138	11,138	11,138	11,138	11,138	11,138	11,138	11,138	11,138	11,138	11,138	11,138
Outcome mean		0.653	0.693	0.696	0.873	0.820	0.774	0.802	0.652	0.693	0.696	0.873	0.820	0.773	0.802

(3) Need quintile 3

		(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	coef.	0.025	0.007	0.016	0.006	0.008	0.022**	0.008							
	stderr.	0.012	0.017	0.011	0.006	0.009	0.011	0.014							
Capitation	coef.								0.005	-0.011	0.001	0.003	0.011	0.009	0.004
	stderr.								0.010	0.009	0.008	0.004	0.007	0.014	0.009
Quality-based	coef.								0.003	-0.002	0.014	0.001	-0.001	0.017**	0.004
	stderr.								0.007	0.011	0.007	0.004	0.005	0.007	0.009
Activity-based	coef.								0.003	0.006	0.002	0.000	0.000	0.001	0.004
	stderr.								0.003	0.006***	0.002	0.000	0.000	0.001	0.004**
Others	coef.								0.006**	0.001	0.001	0.001	0.000	0.008***	0.000
	stderr.								0.003	0.005	0.003	0.002	0.002	0.003	0.004
Observation		11,037	11,037	11,037	11,037	11,037	11,037	11,037	11,037	11,037	11,037	11,037	11,037	11,037	11,037
Outcome mean		0.660	0.703	0.704	0.876	0.818	0.780	0.815	0.660	0.704	0.703	0.876	0.819	0.778	0.814

(4) Need quintile 4

		(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	coef.	0.020	0.010	-0.009	-0.008	0.016*	0.008	0.008							
	stderr.	0.013	0.015	0.012	0.006	0.009	0.010	0.014							
Capitation	coef.								0.023	-0.014	0.003	0.000	0.018*	0.009	0.004
	stderr.								0.019	0.026	0.018	0.008	0.010	0.014	0.018
Quality-based	coef.								-0.006	-0.011	0.007	0.000	-0.011**	-0.005	-0.002
	stderr.								0.007	0.009	0.006	0.004	0.005	0.006	0.007
Activity-based	coef.								0.002	0.002	0.003*	0.000	-0.001	0.001	0.003
	stderr.								0.002	0.002	0.002	0.001	0.001	0.002	0.002
Others	coef.								0.002	0.003	-0.004	-0.002	0.005*	0.002	0.002
	stderr.								0.004	0.004	0.003	0.002	0.003	0.003	0.004
Observation		11,029	11,029	11,029	11,029	11,029	11,029	11,029	11,029	11,029	11,029	11,029	11,029	11,029	11,029
Outcome mean		0.661	0.707	0.710	0.875	0.821	0.786	0.820	0.661	0.707	0.710	0.875	0.822	0.784	0.820

(5) Need quintile 5 (Most Need)

		(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	coef.	0.020*	0.020	0.001	0.004	-0.002	0.000	0.016							
	stderr.	0.012	0.018	0.009	0.006	0.010	0.009	0.011							
Capitation	coef.								0.006	-0.005	0.002	0.000	0.008	0.000	-0.001
	stderr.								0.007	0.007	0.005	0.003	0.009	0.006	0.006
Quality-based	coef.								0.019	0.028	0.002	0.003	0.011	0.001	0.021
	stderr.								0.008**	0.013**	0.007	0.004	0.006*	0.008	0.010**
Activity-based	coef.								0.003	0.002	0.002	0.000	-0.001	0.001	0.003*
	stderr.								0.002	0.002	0.001	0.001	0.001	0.002	0.002
Others	coef.								0.005	0.003	-0.001	0.000	0.002	-0.001	0.003
	stderr.								0.004	0.005	0.003	0.002	0.003	0.003	0.003
Observation		11,103	11,103	11,103	11,103	11,103	11,103	11,103	11,103	11,103	11,103	11,103	11,103	11,103	11,103
Outcome mean		0.684	0.729	0.719	0.881	0.822	0.794	0.837	0.684	0.730	0.719	0.881	0.822	0.793	0.837

Notes: Each column reports estimate from separate regression models. The coefficients represent the percentage change in outcomes associated with a 1% increase in payment per patient. Standard errors clustered at the practice level. A */**/*** indicates significant at the 10/5/1% levels.

Table B3. Heterogeneous effects across deprivation, IFE

(1) Deprivation quintile 1 (Least deprived)

		(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	coef.	-0.001	-0.010	-0.006	-0.002	0.001	0.010	-0.004							
	stderr.	0.012	0.017	0.012	0.005	0.011	0.010	0.012							
Capitation	coef.								0.002	-0.023	-0.005	-0.001	0.023***	0.003	-0.006
	stderr.								0.013	0.018	0.008	0.003	0.007	0.011	0.010
Quality-based	coef.								0.001	-0.005	0.006	0.005*	0.008	-0.007	-0.006
	stderr.								0.007	0.009	0.006	0.003	0.006	0.006	0.007
Activity-based	coef.								0.003*	0.002	0.002	0.000	0.000	0.004*	0.002
	stderr.								0.002	0.002	0.001	0.001	0.001	0.002	0.002
Others	coef.								-0.004	-0.004	-0.002	-0.001	-0.002	0.001	-0.004
	stderr.								0.004	0.005	0.003	0.002	0.003	0.003	0.004
Observation		11,211	11,211	11,211	11,211	11,211	11,211	11,211	11,211	11,211	11,211	11,211	11,211	11,211	11,211
Outcome mean		0.690	0.735	0.723	0.911	0.817	0.801	0.851	0.690	0.736	0.723	0.912	0.817	0.801	0.851

(2) Deprivation quintile 2

		(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	coef.	0.026*	0.046**	0.015	0.011*	0.014	0.015	0.023*							
	stderr.	0.014	0.018	0.010	0.005	0.010	0.011	0.014							
Capitation	coef.								0.021*	0.000	0.005	0.004	0.012	0.025*	0.001
	stderr.								0.011	0.020	0.009	0.004	0.009	0.015	0.008
Quality-based	coef.								-0.001	-0.011	0.005	0.003	-0.004	0.004	0.008
	stderr.								0.008	0.011	0.008	0.005	0.007	0.008	0.009
Activity-based	coef.								0.002	0.002	0.000	0.000	0.001	-0.001	0.001
	stderr.								0.002	0.002	0.001	0.001	0.001	0.002	0.002
Others	coef.								0.002	0.011**	0.004	0.003	0.001	0.004	0.007***
	stderr.								0.004	0.005	0.003	0.002	0.003	0.003	0.004
Observation		11,134	11,134	11,134	11,134	11,134	11,134	11,134	11,134	11,134	11,134	11,134	11,134	11,134	11,134
Outcome mean		0.677	0.725	0.713	0.895	0.815	0.791	0.834	0.677	0.725	0.713	0.896	0.815	0.791	0.834

(3) Deprivation quintile 3

		(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	coef.	-0.007	0.001	-0.009	-0.002	-0.001	0.005	-0.007							
	stderr.	0.014	0.017	0.011	0.006	0.011	0.011	0.013							
Capitation	coef.								-0.010	-0.016	0.002	-0.007**	-0.002	-0.009	-0.015
	stderr.								0.007	0.008	0.004	0.003	0.005	0.009	0.008
Quality-based	coef.								0.007	0.004	0.015**	0.009***	0.004	0.005	0.011
	stderr.								0.007	0.009	0.006	0.003	0.005	0.006	0.009
Activity-based	coef.								0.001	0.003	0.000	-0.001	-0.002	0.002	0.002
	stderr.								0.002	0.002	0.002	0.001	0.001	0.002	0.002
Others	coef.								-0.001	0.001	-0.002	0.001	0.000	0.000	0.000
	stderr.								0.004	0.005	0.003	0.002	0.003	0.003	0.004
Observation		11,071	11,071	11,071	11,071	11,071	11,071	11,071	11,071	11,071	11,071	11,071	11,071	11,071	11,071
Outcome mean		0.656	0.698	0.698	0.874	0.817	0.774	0.806	0.656	0.699	0.698	0.874	0.818	0.774	0.806

(4) Deprivation quintile 4

		(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	coef.	0.006	0.008	-0.005	0.005	0.012	0.011	0.010							
	stderr.	0.011	0.015	0.012	0.006	0.009	0.011	0.012							
Capitation	coef.								0.014*	0.007	0.013	0.004	0.016**	0.004	-0.002
	stderr.								0.008	0.008	0.009	0.004	0.007	0.011	0.008
Quality-based	coef.								-0.012*	-0.013	0.002	-0.002	0.001	0.007	0.002
	stderr.								0.007	0.009	0.007	0.003	0.005	0.007	0.008
Activity-based	coef.								0.002	0.004**	0.002	0.001	0.000	0.001	0.004**
	stderr.								0.002	0.002	0.002	0.001	0.001	0.002	0.002
Others	coef.								0.005	0.003	0.000	0.001	0.002	0.003	0.004
	stderr.								0.003	0.004	0.003	0.001	0.002	0.003	0.003
Observation		11,031	11,031	11,031	11,031	11,031	11,031	11,031	11,031	11,031	11,031	11,031	11,031	11,031	11,031
Adj. R-squared		0.721	0.687	0.557	0.653	0.566	0.465	0.657	0.712	0.676	0.550	0.647	0.558	0.463	0.651
Outcome mean		0.646	0.690	0.690	0.856	0.822	0.767	0.793	0.646	0.690	0.690	0.856	0.823	0.766	0.793

(5) Deprivation quintile 5 (Most deprived)

		(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	coef.	0.030***	0.009	-0.005	0.003	0.010	0.012	0.034***							
	stderr.	0.012	0.015	0.010	0.006	0.007	0.009	0.013							
Capitation	coef.								0.006	-0.009	-0.003	0.002	0.003	-0.001	0.014
	stderr.								0.012	0.010	0.007	0.004	0.005	0.012	0.012
Quality-based	coef.								0.007	0.011	0.012*	0.002	0.001	0.000	0.007
	stderr.								0.006	0.008	0.006	0.004	0.005	0.006	0.007
Activity-based	coef.								0.003	0.001	0.000	-0.001	0.000	0.000	0.004*
	stderr.								0.002	0.003	0.002	0.001	0.001	0.002	0.002
Others	coef.								0.004	0.001	-0.003	0.001	0.003	0.004	0.005*
	stderr.								0.003	0.004	0.003	0.002	0.002	0.003	0.003
Observation		10,968	10,968	10,968	10,968	10,968	10,968	10,968	10,968	10,968	10,968	10,968	10,968	10,968	10,968
Outcome mean		0.639	0.675	0.690	0.835	0.830	0.762	0.779	0.639	0.676	0.689	0.835	0.830	0.761	0.778

Notes: Each column reports estimate from separate regression models. The coefficients represent the percentage change in outcomes associated with a 1% increase in payment per patient. Standard errors clustered at the practice level. A */**/*** indicates significant at the 10/5/1% levels.

Table B4. Heterogeneous effects across list size, IFE

(1) List size quintile 1 (Smallest)

		(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	coef.	0.023**	0.020*	0.023	0.012**	0.010	0.026***	0.030***							
	stderr.	0.010	0.012	0.009	0.006	0.007	0.008	0.011							
Capitation	coef.								0.003	-0.002	0.004	0.001	0.002	0.004	0.005
	stderr.								0.008	0.005	0.003	0.004	0.003	0.006	0.005
Quality-based	coef.								0.005	0.005	0.002	0.001	0.000	-0.002	0.011*
	stderr.								0.005	0.006	0.006	0.003	0.004	0.006	0.006
Activity-based	coef.								0.001	0.000	0.002	0.000	0.001	0.001	0.000
	stderr.								0.001	0.002	0.002	0.001	0.001	0.002	0.002
Others	coef.								0.005**	0.005	0.004	0.002*	0.004**	0.005	0.004
	stderr.								0.002	0.003	0.002	0.001	0.002	0.002	0.003
Observation		10,801	10,801	10,801	10,801	10,801	10,801	10,801	10,801	10,801	10,801	10,801	10,801	10,801	10,801
Outcome mean		0.698	0.754	0.706	0.870	0.833	0.773	0.829	0.697	0.754	0.706	0.870	0.834	0.771	0.828

(2) List size quintile 2

		(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	coef.	0.013	0.003	-0.013	0.003	0.003	0.014	0.005							
	stderr.	0.011	0.014	0.009	0.005	0.008	0.008	0.011							
Capitation	coef.								-0.003	-0.008	-0.004	-0.004	0.003	0.004	-0.003
	stderr.								0.008	0.008	0.007	0.003	0.004	0.006	0.007
Quality-based	coef.								0.002	-0.002	0.005	-0.001	0.005	-0.001	0.012**
	stderr.								0.006	0.007	0.006	0.003	0.005	0.007	0.006
Activity-based	coef.								0.001	0.002	-0.001	-0.001	0.001	0.001	0.001
	stderr.								0.001	0.002	0.001	0.001	0.001	0.002	0.001
Others	coef.								0.008***	0.007*	0.000	0.003**	0.001	0.003	0.004
	stderr.								0.003	0.004	0.003	0.001	0.002	0.002	0.003
Observation		11,060	11,060	11,060	11,060	11,060	11,060	11,060	11,060	11,060	11,060	11,060	11,060	11,060	11,060
Outcome mean		0.686	0.719	0.702	0.870	0.828	0.779	0.818	0.685	0.719	0.702	0.870	0.828	0.778	0.817

(3) List size quintile 3

		(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	coef.	-0.012	-0.016	-0.006	0.006	0.015*	-0.007	-0.009							
	stderr.	0.011	0.014	0.010	0.005	0.008	0.009	0.011							
Capitation	coef.								0.000	-0.021	-0.003	-0.001	0.018**	-0.007	-0.012
	stderr.								0.013	0.015	0.008	0.004	0.008	0.011	0.012
Quality-based	coef.								0.006	0.005	-0.002	0.000	0.000	-0.003	0.004
	stderr.								0.006	0.009	0.007	0.004	0.005	0.007	0.008
Activity-based	coef.								0.003*	0.000	0.004***	0.000	0.002	0.003*	0.003**
	stderr.								0.002	0.002	0.001	0.001	0.001	0.002	0.002
Others	coef.								-0.003	-0.002	-0.006**	0.001	0.003	-0.002	-0.003
	stderr.								0.003	0.004	0.003	0.002	0.002	0.003	0.003
Observation		11,132	11,132	11,132	11,132	11,132	11,132	11,132	11,132	11,132	11,132	11,132	11,132	11,132	11,132
Outcome mean		0.662	0.697	0.703	0.874	0.820	0.780	0.811	0.662	0.696	0.703	0.874	0.820	0.780	0.810

(4) List size quintile 4

		(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	coef.	0.011	0.017	0.005	-0.001	-0.010	0.004	0.026**							
	stderr.	0.011	0.017	0.010	0.006	0.009	0.010	0.012							
Capitation	coef.								0.005	-0.004	0.013	0.002	-0.001	0.000	-0.002
	stderr.								0.011	0.011	0.008	0.005	0.006	0.014	0.008
Quality-based	coef.								-0.005	-0.010	0.017**	0.003	0.002	0.000	0.003
	stderr.								0.008	0.010	0.008	0.004	0.005	0.007	0.009
Activity-based	coef.								0.001	0.002	0.000	-0.001	-0.002	0.002	0.002
	stderr.								0.002	0.002	0.001	0.001	0.001	0.002	0.002
Others	coef.								0.004	0.002	0.001	0.002	-0.003	-0.001	0.007**
	stderr.								0.003	0.004	0.003	0.002	0.002	0.003	0.003
Observation		11,206	11,206	11,206	11,206	11,206	11,206	11,206	11,206	11,206	11,206	11,206	11,206	11,206	11,206
Outcome mean		0.644	0.685	0.704	0.879	0.814	0.783	0.809	0.644	0.685	0.704	0.879	0.815	0.783	0.809

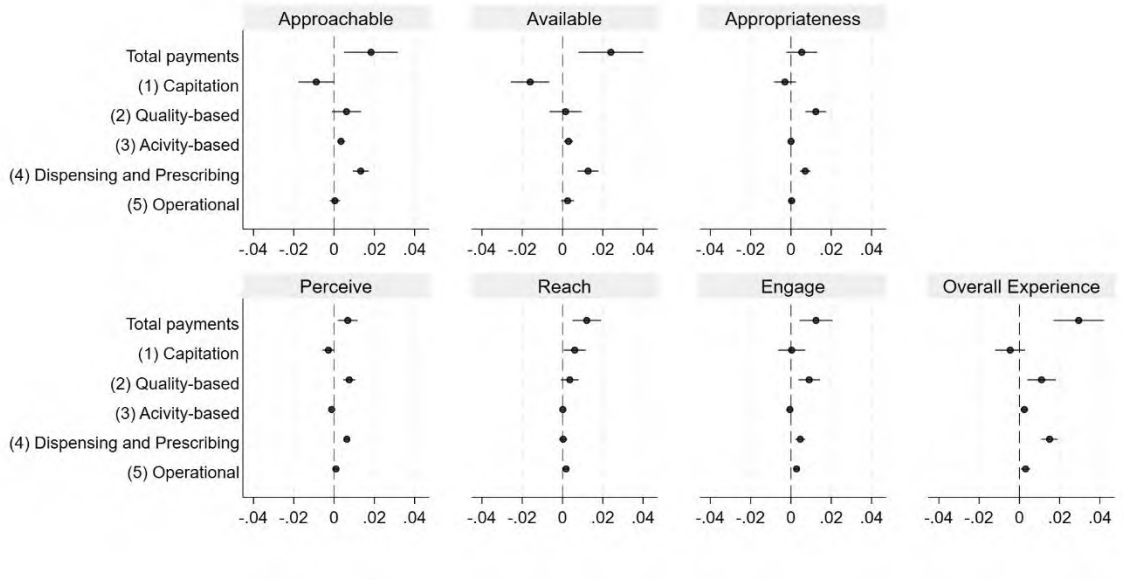
(5) List size quintile 5 (Largest)

		(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall	(8) Approach	(9) Available	(10) Appropriate	(11) Perceive	(12) Reach	(13) Engage	(14) Overall
Total payments	coef.	0.015	0.013	-0.013	0.001	0.011	0.018*	0.011							
	stderr.	0.012	0.015	0.010	0.006	0.009	0.011	0.013							
Capitation	coef.								0.012	-0.007	-0.003	-0.004	0.011	0.005	0.001
	stderr.								0.012	0.013	0.009	0.005	0.009	0.012	0.009
Quality-based	coef.								0.000	0.001	0.010**	0.007**	0.005	0.008	0.004
	stderr.								0.006	0.007	0.005	0.003	0.005	0.005	0.007
Activity-based	coef.								0.003	0.005**	0.000	0.000	0.000	-0.003	0.004**
	stderr.								0.002	0.002	0.002	0.001	0.001	0.002	0.002
Others	coef.								-0.003	-0.003	-0.002	-0.001	0.000	0.005*	0.000
	stderr.								0.004	0.005	0.003	0.002	0.003	0.003	0.004
Observation		11,216	11,216	11,216	11,216	11,216	11,216	11,216	11,216	11,216	11,216	11,216	11,216	11,216	11,216
Outcome mean		0.621	0.671	0.699	0.880	0.806	0.781	0.798	0.620	0.671	0.699	0.879	0.807	0.780	0.797

Notes: Each column reports estimate from separate regression models. The coefficients represent the percentage change in outcomes associated with a 1% increase in payment per patient. Standard errors clustered at the practice level. A */**/*** indicates significant at the 10/5/1% levels.

Appendix C: Sensitivity analysis with dispensing and prescribing payments

Figure C1. Associations between lagged per-patient payment, in total and by types, and access outcomes



Notes: The figure presents coefficients with 95% confident interval. The coefficients represent the percentage change in outcomes associated with a 1% increase in per-patient payment. CI, Confidence interval; TWFE, Two-way fixed effects estimation.

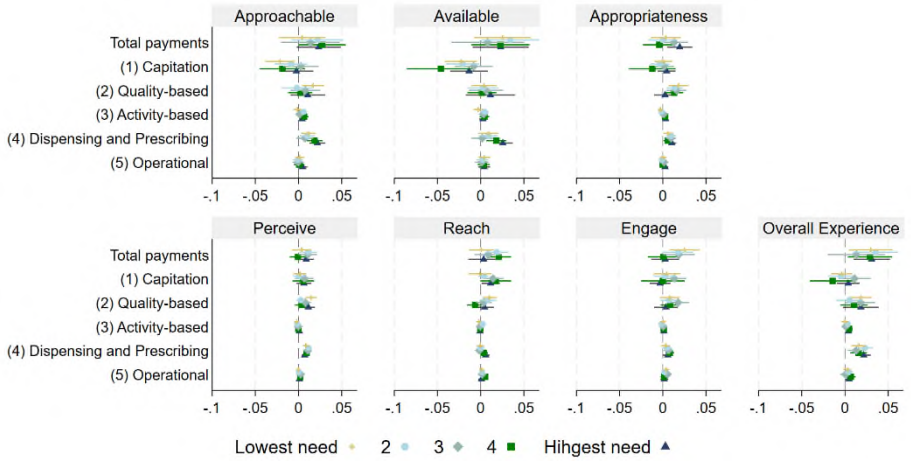
Table C1. Associations between lagged per-patient payment, in total and by types, and access outcomes

	(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall
Capitation	-0.009*	-0.016***	-0.003	-0.003*	0.006**	0.000	-0.005
	(0.005)	(0.005)	(0.003)	(0.002)	(0.003)	(0.003)	(0.004)
Quality-based	0.006*	0.002	0.012***	0.008***	0.004	0.009***	0.011***
	(0.004)	(0.004)	(0.003)	(0.002)	(0.002)	(0.003)	(0.004)
Activity-based	0.003***	0.003**	0.000	-0.001***	0.000	-0.001	0.002***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
Dispensing & Prescribing	0.013***	0.013***	0.007***	0.006***	0.000	0.005***	0.015***
	(0.002)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Operational	0.000	0.003	0.000	0.001*	0.002**	0.003***	0.003***
	(0.001)	(0.002)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
Adjusted R-squared	0.742	0.705	0.570	0.681	0.582	0.488	0.667
Outcome mean	0.662	0.705	0.703	0.875	0.82	0.779	0.813

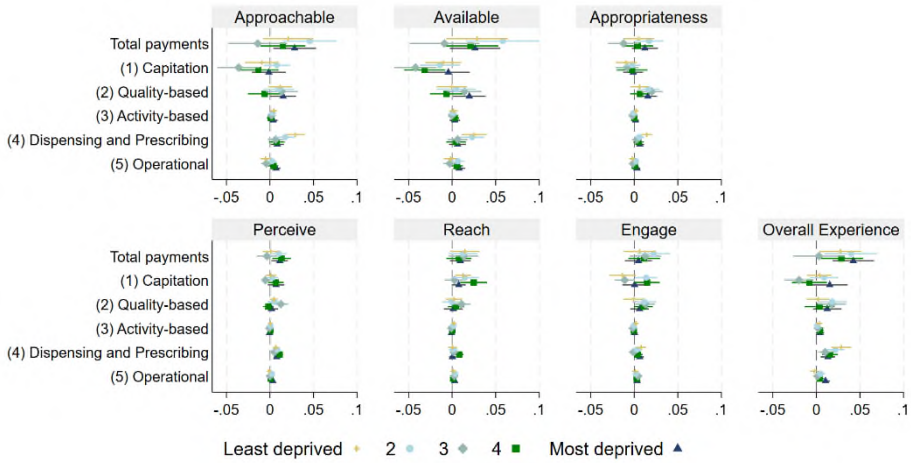
Notes: Each column reports estimate from separate regression models with 55,415 practice-year observations (7,445 unique practices). The coefficients represent the percentage change in outcomes associated with a 1% increase in payment per patient. Standard errors clustered at the practice level. A */**/*** indicates significant at the 10/5/1% levels.

Figure C2. Heterogeneous effects, TWFE

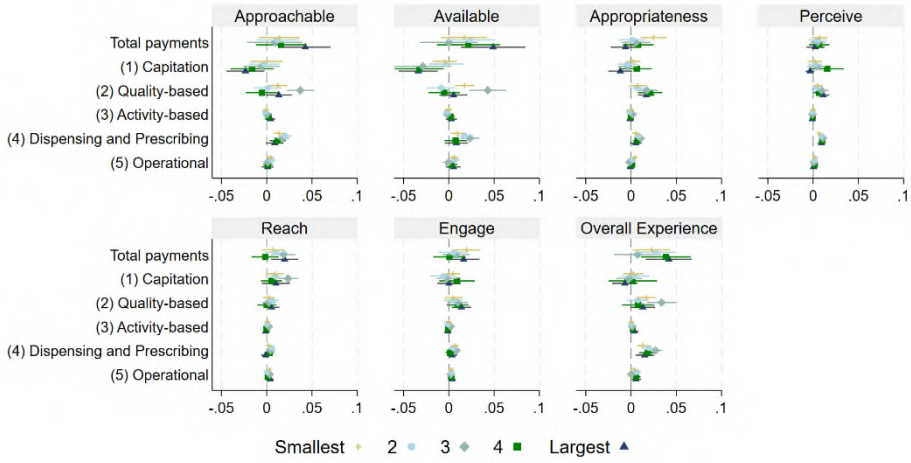
(a) Heterogeneity by need



(b) Heterogeneity by deprivation



(c) Heterogeneity by list size



Notes: The coefficients represent the percentage change in outcomes associated with a 1% increase in per-patient payment in total and by type across quintiles of need, deprivation, and list size. CI, Confidence interval; TWFE, Two way fixed effect.

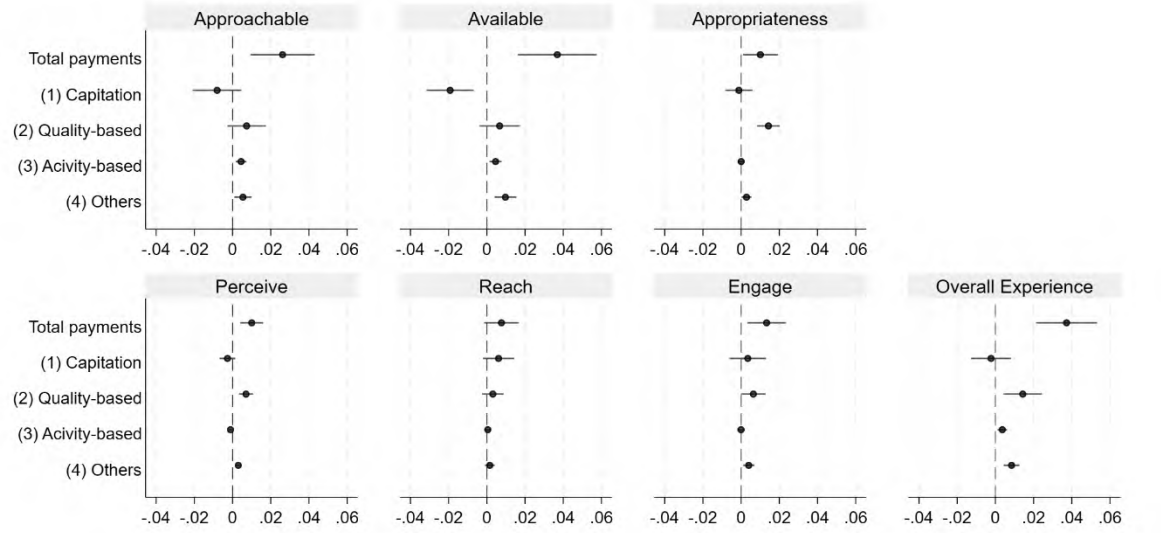
Appendix D: Sensitivity analysis using a balanced panel approach

Table D1. Descriptive statistics, balanced panel

	Unbalanced		Balanced	
	Mean	SD	Mean	SD
Payment: 1-year lagged per-patient payment, £				
Total payment	177.8	62.8	173.6	51.8
Capitation payment	101.5	21.5	100.5	16.2
Quality-based payment	14.3	3.8	14.3	3.5
Activity-based payment	14.2	12.4	14.8	12.6
Direct Enhanced Services (DES)	3.7	3.7	4	3.7
Local Incentive Schemes (LIS)	9.4	10.8	9.6	10.9
Non-DES	.1	0.2	0.1	0.2
PCN Participation	1.8	0.4	1.9	0.4
Winter Access Fund	.7	3.8	0.7	4.3
Others	45.8	49.7	42.4	40.9
Operational payment	29.4	31.7	29.5	27.9
Dispensing and prescribing related payment	18.5	42.9	14.5	32.9
Dispensing fee	3.2	10.6	2.2	8.2
Prescribing fee	.6	0.9	0.7	0.8
Reimbursement of drugs	14.7	32.9	11.6	25.2
Outcomes: proportion of positive experience, %				
Overall experience	81.3	11.4	79.2	11.5
Provider approachability	66.2	10.9	63.8	10.6
Provider availability	70.5	14.2	66.9	13.8
Provider appropriateness	70.3	7.6	69.2	7.4
Population ability to perceive	87.5	6.8	86.7	6.8
Population ability to reach	82	7.5	81.2	7.8
Population ability to engage	77.9	8.0	77.5	7.8
Other variables: proportion of registered population, %				
Female	50.6	5.8	50.8	5.6
Age 24 or below	9.8	5.7	9.7	5
Age 25 to 34	13.7	7.8	13.1	7
Age 35 to 44	13.7	6.7	13.2	6.3
Age 45 to 54	14.4	6.5	13.8	6.3
Age 55 to 64	12.6	5.5	12.3	5.2
Age 65 to 74	11.3	5.3	11.1	4.9
Age 75 or above	10.2	4.4	10.3	4.2
White	82.7	22	83.1	21.5
Mixed	1.4	2	1.4	1.9
Asian	9.5	15.5	9.4	15.5
Black	3.6	6.5	3.4	6.1
Other ethnicities	2.9	4.5	2.6	4
Christian	54.4	13.9	54.4	13.5
Hindu	2.1	5.5	1.9	4.6
Jewish	.5	3.1	.5	2.6
No religion	30	11.2	30.3	11
Fulltime worker	44.2	8.6	44.1	8.2
Part-time worker	13.4	4.2	13.4	4.1
Student	4	5	3.8	3.7
Unemployed	5.1	4.5	5	4.2
Disabled	4.4	3.3	4.5	3.2
Smoker	42.5	8.8	42.6	8.6
With long-term conditions	52.9	8.3	53.4	8
Asthma	6.1	1.4	6.2	1.3
Cancer	2.8	1.2	2.9	1.1
Coronary heart disease	3.2	1.1	3.3	1
Chronic kidney disease	3.3	1.7	3.4	1.6
Chronic obstructive pulmonary disease	2	.9	2	0.9
Dementia	.7	.4	0.8	0.4
Depression	8.2	3.6	8.5	3.6
Diabetes mellitus	5.8	1.6	6	1.5
Epilepsy	.6	.3	0.7	0.4
Heart Failure	.9	.4	0.9	0.4
Hypertension	14.4	3.7	14.6	3.4
Learning disability	.5	.3	0.5	0.3
Mental health	1	.4	1	0.4
Obesity	8	3.1	8.2	3.1
Osteoporosis	.2	.3	0.2	0.3
Peripheral arterial disease	.6	.3	0.6	0.3
Palliative care	.4	.4	0.4	0.4
Rheumatoid arthritis	.6	.2	0.6	0.2
Other variables				
List size	8610.5	5374.8	9320	5515.5
NHS primary care need index	1	0.1	1	0.1
Index of multiple deprivation (IMD)	23.6	11.6	23.9	11.7

Notes: SD, Standard deviation. 1st %, first percentile. 99th %, 99th percentile. PCN, Primary Care Network. Negative payment amount may occur where there has been an overpayment in a previous period and money has subsequently been recovered.

Figure D1. Associations between lagged per-patient payment, in total and by types, and access outcomes, balanced panel



Notes: The figure presents coefficients with 95% confident interval. The coefficients represent the percentage change in outcomes associated with a 1% increase in per-patient payment by type. CI, Confidence interval; TWFE, Two-way fixed effects estimation.

Table D2. Associations between lagged per-patient payment, in total and by types, and access outcomes, balanced panel

(a) Total payments

	(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall
Total payments	0.026***	0.037***	0.010**	0.010***	0.008*	0.013***	0.037***
	(0.009)	(0.011)	(0.005)	(0.003)	(0.005)	(0.005)	(0.008)
Adjusted R-squared	0.719	0.689	0.563	0.679	0.594	0.471	0.719
Outcome mean	0.662	0.705	0.703	0.875	0.82	0.779	0.813

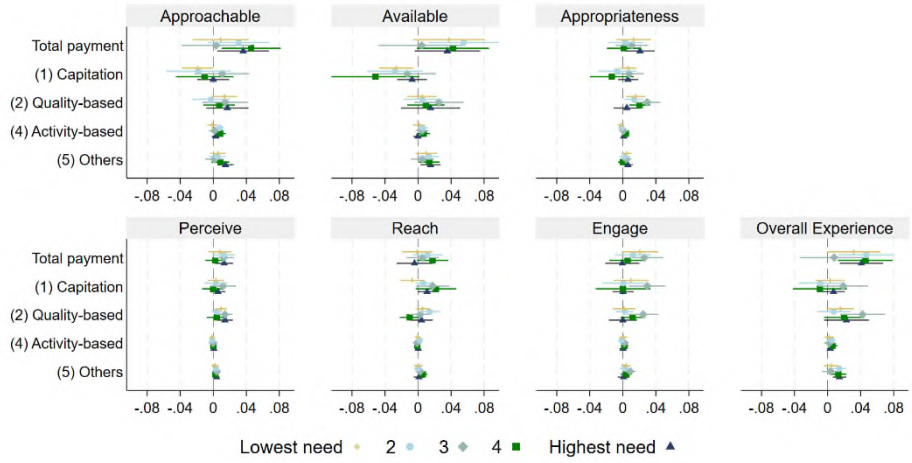
(b) Payment types

	(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall
Capitation	-0.008	-0.019***	-0.001	-0.003	0.006	0.003	-0.002
	(0.006)	(0.006)	(0.004)	(0.002)	(0.004)	(0.005)	(0.005)
Quality-based	0.007	0.007	0.014***	0.007***	0.003	0.006**	0.014***
	(0.005)	(0.005)	(0.003)	(0.002)	(0.003)	(0.003)	(0.005)
Activity-based	0.004***	0.005***	0.000	-0.001**	0.001	-0.000	0.004***
	(0.001)	(0.002)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
Others	0.005**	0.010***	0.003**	0.003***	0.002	0.004***	0.008***
	(0.002)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Adjusted R-squared	0.751	0.724	0.613	0.716	0.641	0.531	0.692
Outcome mean	0.662	0.705	0.703	0.875	0.82	0.779	0.813

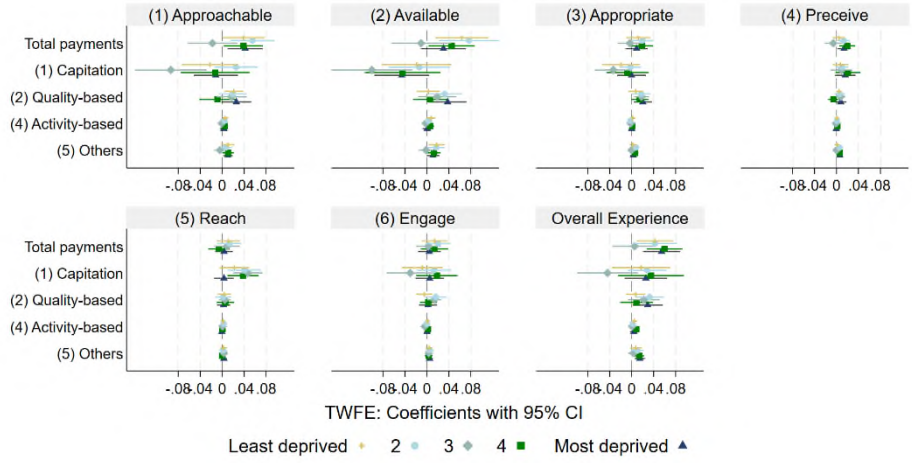
Notes: Each column reports estimate from an independent regression model with 3,904 unique practices. The coefficients represent the percentage change in outcomes associated with a 1% increase in payment per patient. Standard errors clustered at the practice level. A */**/*** indicates significant at the 10/5/1% levels.

Figure D2. Heterogeneous effects, TWFE, balanced panel

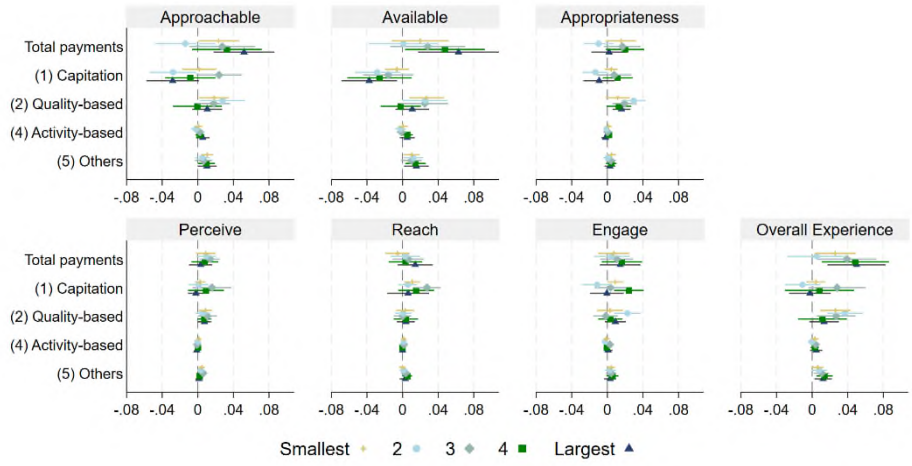
(a) Heterogeneity by need



(b) Heterogeneity by deprivation



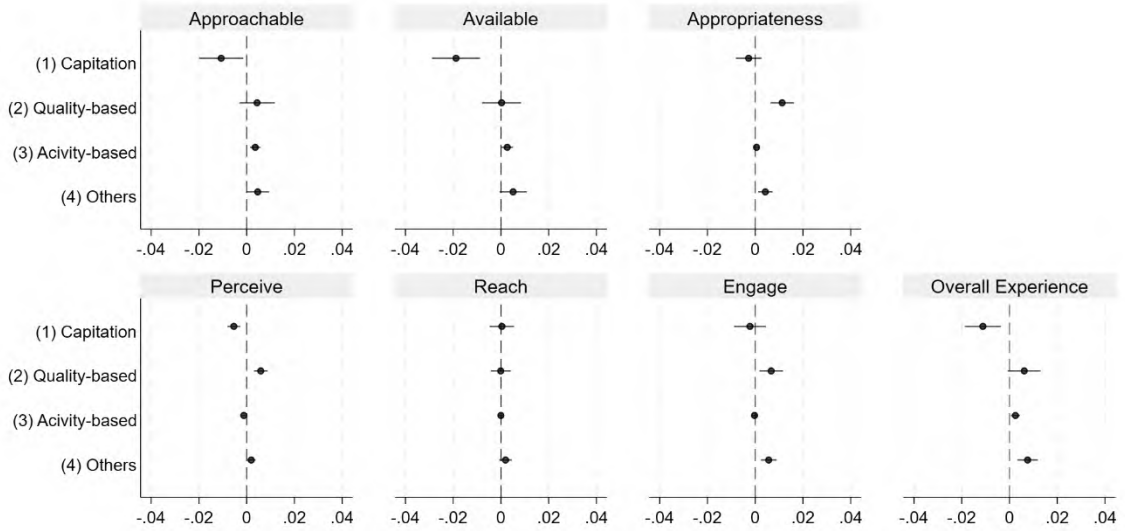
(c) Heterogeneity by list size



Notes: The figure presents coefficients with 95% confident interval. The coefficients represent the percentage change in outcomes associated with a 1% increase in per-patient payment in total and by type across quintiles of need, deprivation, and list size. CI, Confidence interval; TWFE, Two-way fixed effect.

Appendix E: Sensitivity analysis using share of payment

Figure E1. Associations between lagged share of payment by types and access outcomes



Notes: The figure presents coefficients with 95% confident interval. The coefficients represent the percentage change in outcomes associated with a 1% increase in share of payment.

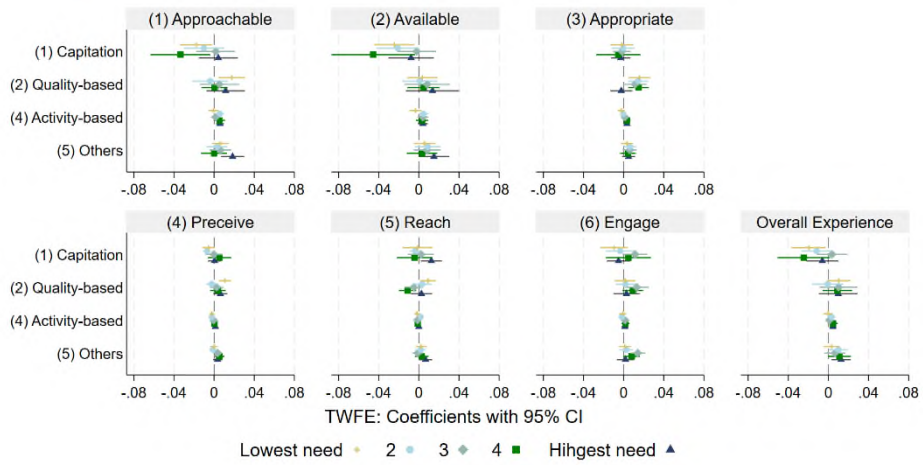
Table E1. Associations between lagged share of payment by types and access outcomes

	(1) Approach	(2) Available	(3) Appropriate	(4) Perceive	(5) Reach	(6) Engage	(7) Overall
Capitation	-0.011**	-0.019***	-0.003	-0.005***	0.000	-0.002	-0.011***
	(0.005)	(0.005)	(0.003)	(0.001)	(0.003)	(0.003)	(0.004)
Quality-based	0.004	0.000	0.011***	0.006***	-0.000	0.007***	0.006*
	(0.004)	(0.004)	(0.003)	(0.001)	(0.002)	(0.003)	(0.003)
Activity-based	0.004***	0.003**	0.001	-0.001***	-0.000	-0.000	0.003***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
Others	0.005*	0.005*	0.004***	0.002**	0.002	0.006***	0.008***
	(0.002)	(0.003)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
Adjusted R-squared	0.777	0.745	0.628	0.724	0.639	0.557	0.712
Outcome mean	0.662	0.705	0.703	0.875	0.82	0.779	0.813

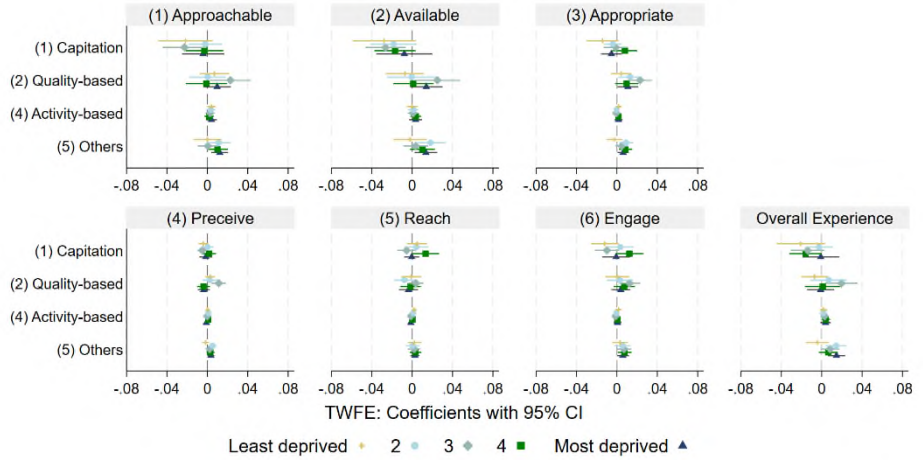
Notes: Each column reports estimate from an independent regression model with 3,904 unique practices. The coefficients represent the percentage change in outcomes associated with a 1% increase in share of payment. Standard errors clustered at the practice level. A */**/*** indicates significant at the 10/5/1% levels.

Figure E2. Heterogeneous effects, share of payment

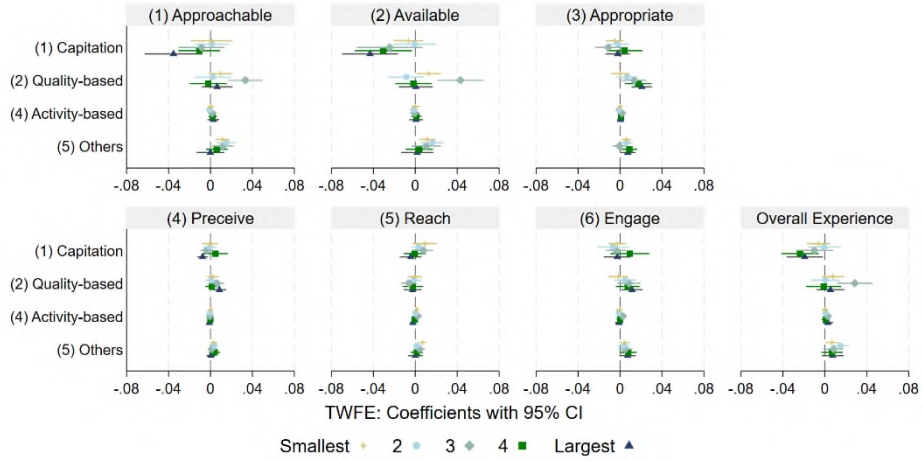
(a) Heterogeneity by need



(b) Heterogeneity by deprivation



(c) Heterogeneity by list size



Notes: The figure presents coefficients with 95% confident interval. The coefficients represent the percentage change in outcomes associated with a 1% increase in share of payment in total and by type across quintiles of need, deprivation, and list size. CI, Confidence interval; TWFE, Two-way fixed effect.