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Authors

Huckfeldt, Peter J
Sood, Neeraj
Escarce, José J
et al.

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Effects of Medicare Payment Reform: Evidence from the Home Health Interim and Prospective Payment Systems

Peter J Huckfeldt[a,*], **Neeraj Sood**[a,b,c], **José J Escarce**[a,c,d], **David C Grabowski**[e], and **Joseph P Newhouse**[c,e]

[a] RAND Corporation, Santa Monica, California

[b] University of Southern California (USC), Los Angeles, California

[c] National Bureau of Economic Research (NBER), Cambridge, Massachusetts

[d] University of California Los Angeles, Los Angeles, California

[e] Harvard University, Boston, Massachusetts

Abstract

Medicare continues to implement payment reforms that shift reimbursement from fee-for-service towards episode-based payment, affecting average and marginal payment. We contrast the effects of two reforms for home health agencies. The Home Health Interim Payment System in 1997 lowered both types of payment; our conceptual model predicts a decline in the likelihood of use and costs, both of which we find. The Home Health Prospective Payment System in 2000 raised average but lowered marginal payment with theoretically ambiguous effects; we find a modest increase in use and costs. We find little substantive effect of either policy on readmissions or mortality.

Keywords

Medicare; treatment intensity; selection; cream skimming; mortality; prospective payment

1. Introduction

With the passage of the Patient Protection and Affordable Care Act (ACA), policymakers face the challenge of minimizing health care costs while maintaining or improving quality of care. One prominent approach shifts provider payment from fee-for-service to episode-based payments to improve efficiency and accountability. For example, the Center for Medicaid and Medicare Services is currently piloting programs that provide a fixed payment for an acute hospital stay and any subsequent post-acute care (Medpac 2013). However, these

*Corresponding Author. RAND Corporation, 1776 Main Street, Santa Monica, CA 90407 Tel: 310-393-0411 huckfeld@rand.org.

reforms require an appropriate definition of a treatment "episode" and understanding the effects of alternate payment rules.

How can prior experience with payment change inform the current efforts to reform Medicare payment? The Medicare home health benefit has transitioned through multiple payment regimes and thus provides an excellent laboratory to study the influence of marginal and average payment changes on home health admissions, provider costs, and Medicare costs.

In 1983, in an attempt to curtail rapidly increasing inpatient hospital costs, Medicare instituted the Inpatient Prospective Payment System, which provides a single payment for the inpatient stay, based on principal diagnosis, complications and comorbidities, procedure use, and local wages. However, post-acute services including home health care were still reimbursed on a cost basis subject to upper limits. As a result, admissions, patient visits, and resource use skyrocketed in home health agencies, resulting in Medicare home health expenditures increasing from $2 billion in 1987 to $17 billion in 1997 (Medpac 2002).

In the Balanced Budget Act of 1997 (BBA 1997), Congress responded to spiraling post-acute care use by mandating prospective payment systems for post-acute care. Because a workable system for home health agencies was not available, Congress mandated the almost immediate adoption of an "Interim Payment System" (IPS) in October 1997. The IPS imposed substantially lower limits on Medicare reimbursement to home health agencies. It reduced average payments per visit, instituted an annual per-patient payment cap, and effectively eliminated marginal reimbursement past the limits. Subsequently, Medicare devised a home health agency prospective payment system (PPS) that provided reimbursement for each 60-day home health episode as a function of patients' clinical status, functional status, and service use (Medpac 2011). The PPS, implemented in October 2000, increased average payments to home health agencies, but, by some metrics, marginal reimbursement within a 60-day home health episode was further reduced[1].

A number of papers examine the impacts of the Home Health IPS and PPS on payments, costs, and patient outcomes. Previous research has shown that the IPS reduced both the probability of using home health and the number of visits per patient (McCall, Komisar et al. 2001, McCall, Korb et al. 2003, McKnight 2006). This decrease in utilization was concentrated in less healthy Medicare patients but had little or no effect on adverse health outcomes (McKnight 2006). Additionally, the number of home health agencies fell by over 30% between 1997 and 2000 (Medpac 2011). Exiting facilities were more likely to be recent market entrants, were located in more competitive markets, and provided a higher number of visits per patient; however, newer entrants that remained were more likely to expand their service area (Porell, Liu et al. 2006). Research on the PPS is more limited, but finds a greater use of therapy relative to home health aide visits, with small changes in patient outcomes or quality of care (McCall, Korb et al. 2004, Schlenker, Powell et al. 2005, Medpac 2010).

[1]There are outlier payments for exceptionally costly patients, per visit payments for "short stay" outliers, and until 2008 agencies received additional payment for providing 10 or more rehabilitation visits.

In this paper, we contribute to the previous literature by analyzing the Home Health IPS and PPS in a single unified framework, contrasting their differing effects on marginal and average reimbursement. Ideally, we would be able to estimate separate elasticities of treatment with respect to average and marginal reimbursement. However, because changes in average and marginal reimbursement occurred simultaneously, we pursue a reduced form approach that contrasts the IPS (which reduced both average and marginal reimbursement) with the PPS (which increased average reimbursement but reduced marginal reimbursement). As part of this strategy, we compare the effects of each reform on average payments to hypothesize the behavioral responses specific to the accompanying changes in marginal reimbursement. We describe a conceptual framework that models home health agencies' admission and treatment policies as a function of Medicare reimbursement policy and provides separate predictions for the IPS and the PPS. We develop an empirical strategy that simulates changes in admissions and resource use after each policy shift for a constant cohort of patients, thereby controlling for patient selection or changes in the composition of patients over time. Additionally, we estimate admission and treatment functions for a single cohort of patients, and use the estimates to simulate admission probabilities and resource use for successive patient cohorts to isolate selection effects. We also investigate the impacts of each policy on costs in other post-acute care settings and patient outcomes including mortality and hospital readmission. Finally, we estimate heterogeneous effects on admissions and costs based on differential changes in Medicare payments to gauge the relative importance of average and marginal reimbursement. Throughout our empirical analysis, we use a rich dataset comprised of 100 percent Medicare acute and post-acute claims, denominator files, and provider data over the period 1996 through 2002. Our focus is on patients discharged from hospitals after one of three primary diagnoses: stroke, hip fracture, or lower extremity joint replacement.

Our conceptual model predicts that home health agencies' admissions and resource use will decrease with the IPS, but shows that the PPS has ambiguous effects due to offsetting changes in marginal and average reimbursement. Our estimates confirm that the IPS substantially decreased Medicare payments. We show that this decline in average and marginal reimbursement led to a sharp decline in home health admissions and resource use conditional on admission. In contrast, while the PPS increased average payments to providers above pre-IPS levels (in nominal terms), admissions and resource use conditional on admission increased only slightly. In both cases, we find little change in admissions or resource use conditional on admission due to patient selection. Despite the large changes in Medicare payments to home health agencies over the sample period, we find little evidence of substitution towards or away from other post-acute facilities as a result of the IPS or PPS. In addition, we find little evidence that payment reforms affected mortality or readmissions. We find heterogeneous effects on costs that vary with differential changes in average payments. Overall our results suggest that providers are responsive to both marginal and average reimbursement in determining treatment intensity and admissions, but changes in resource use and admissions induced by these payment changes had little impact on the patient health outcomes.

The paper proceeds as follows. Section 2 provides background on home health agencies and changes in reimbursement policy. Section 3 discusses our conceptual framework. Section 4

describes the data, section 5 discusses the empirical strategy, section 6 describes the results, and section 7 concludes.

2. The Home Health IPS and PPS

The Medicare home health benefit provides skilled nursing, physical therapy, nurse aide, and medical social work services for Medicare beneficiaries who require such services (as judged by a physician) and are unable to leave their homes without difficulty, but who do not require inpatient care. Other post-acute care settings (such as skilled nursing and inpatient rehabilitation facilities) provide similar services, but for patients who need to receive such care in an inpatient setting (and in the case of inpatient rehabilitation, are able to complete three hours of intensive therapy each day). In addition, while Medicare only pays for episodes in skilled nursing facilities and inpatient rehabilitation facilities after a hospital stay, beneficiaries may receive home health services outside of the post-hospital discharge period if otherwise eligible. In 2011, 3.4 million fee-for-service patients received the home-health benefit, resulting in $18.4 billion in Medicare home health expenditures (Medpac 2013).

In 1983, the Medicare inpatient prospective payment system was implemented, providing a single payment to providers for an acute care episode as a function of patients' principal diagnosis, procedures used, complications and comorbidities, and adjustments based on local labor market conditions. Acute care length-of-stay steadily decreased in the years immediately following the acute PPS, with little immediate change in post-acute use. Court decisions in the late 1980s, however, held certain regulations governing eligibility for post-acute services to be illegal. Specifically, *Fox versus Bowen* in 1986 (for skilled nursing) and *Duggan versus Bowen* in 1988 (for home health services) expanded the criteria for eligibility for receiving post-acute care. In particular, the latter decision allowed patients with stable health care needs (rather than patients expected to improve) to receive home health services (Liu, Gage et al. 1999) . Subsequently acute providers “unbundled” the marginal day from the acute inpatient episode and moved it to a post-acute setting, thereby receiving marginal reimbursement from Medicare. Indeed, the early 1990s saw explosive growth in hospital-based post-acute units and post-acute care use more generally (Newhouse 2002). Between 1987 and 1997, the number of Medicare patients using home health services doubled, the number of visits per patient increased from 23 to 78, and, as mentioned above, Medicare spending on home health services grew from $2 billion to $17 billion (Grimaldi 2002, Medpac 2002) .

Congress and Medicare responded to ballooning post-acute expenditures by mandating prospective payment systems for all types of post-acute care in the Balanced Budget Act of 1997, but also immediately imposed the Home Health Interim Payment System (IPS) in October 1997. Prior to October 1997, home health agencies were reimbursed based on the lower of their actual costs or a per-visit cost limit, which was applied in the aggregate for each facility by multiplying the number of visits by type by a type-specific cost-limit equal to 112% of national average costs for that type of visit [2]. This system limited reimbursement

[2]The “type” of a visit was based on the services included as a part of that visit, such as skilled nursing or physical therapy.

per visit, but placed no limit on the number of visits per patient. Starting October 1997, home health agencies were reimbursed based on the lower of their actual costs, a per-visit cost limit, or additionally, a per beneficiary cost limit (also applied in the aggregate across all Medicare patients for each facility) (Grimaldi 2002). For home health agencies that had entered the market after 1994, the per-patient cap on payments was set equal to national median per-patient costs. For older facilities, the limit was a weighted average of census division per-patient costs (25%) and agency specific per-patient costs (75%) in 1994 (McKnight 2006) [3]. The IPS also reduced the per-visit cap to 105 percent of median costs in 1994 for freestanding home health agencies, began counting services contracted out towards the per-patient and per-visit caps, and targeted fraudulent practices by home health providers (Grimaldi 2002). Thus, agencies with reasonable costs below these limits could have received additional reimbursement for increasing costs per visits or visits per patient, while agencies with costs above these limits would receive less reimbursement for providing the same services per visit or numbers of visits per patient.

The Home Health IPS was meant to be a temporary measure to contain home health costs, and, as called for in the law, the Home Health Prospective Payment System (PPS) was implemented October 1, 2000. Medicare currently continues to pay home health agencies using the prospective payment system, but some changes to the system have been made since the original implementation. The Home Health PPS provides predetermined prospective rates for a 60-day episode of home health based on a patient's “home health resource group,” which is determined as a function of clinical and functional status (both assessed by a nurse or therapist) and expected service utilization (based on documented physician orders). Clinical status was initially based on severity level (on a four points scale) reflecting whether the primary diagnosis was neurological, orthopedic, related to diabetes, and other clinical characteristics. Functional status was measured on a five-level scale and indicated patients’ performance on activities of daily living. The service utilization parameter added a non-prospective aspect to the payment system, since those patients expected to receive ten or more physical, occupational, or speech therapy payments received additional reimbursement[4]. Each index produced a numerical score; taking the sum of indices across dimensions assigned a patient to a home health resource group. The home health resource group combined with geographic wage index adjustments then determines the 60-day payment rate. With the exception of episodes with low visit counts (<5 visits) and exceptionally high cost episodes, home health providers receive the same reimbursement for an episode of care for a particular home health resource group regardless of the number of visits. However, if beneficiaries are still homebound and need skilled care at the end of 60 days, Medicare will pay for an additional 60-day episode. With the caveat that the payment rate was determined in part by the number of therapy visits, the home health PPS represented a reduction in marginal reimbursement. We summarize marginal and average payment before and after each reform in Appendix Table A.1.

[3]The per patient cap was increased by a third of the difference between the national median limit and the prior limit starting in October 1998 due to complaints by older facilities.

[4]In response to increasing numbers of episodes with 10 to 13 therapy visits, Medicare changed this formula in 2008 to include 9 thresholds increasing payments more gradually.

Figure 1 shows average Medicare reimbursement per-home health patient separately for patients discharged from the hospital after a primary diagnosis of stroke, hip fracture, and lower extremity joint replacement (hereafter referred to as joint replacement). The first vertical line indicates the quarter prior to the Home Health IPS and the second vertical line indicates the quarter prior to the Home Health PPS. This figure shows that the IPS considerably decreased average Medicare reimbursement for home health patients, while the PPS increased average reimbursement to above pre-IPS levels (in nominal terms)[5]. Marginal reimbursement, however, was further reduced under the PPS. The independent trajectories of average and marginal payments under the IPS and PPS allow us to investigate the separate effects of marginal versus average reimbursement on admissions and resource use.

3. Conceptual Framework

In this paper, we are interested in providers' decisions to admit patients and the level of treatment given to patients conditional on admission as a function of both average and marginal reimbursement. We use a conceptual model, developed by Sood, Huckfeldt, et al. (2013), drawing on previous models by Hodgkin and McGuire (1994) and Ellis and McGuire (1996). Hodgkin and McGuire model providers' treatment decisions as a function of marginal and average payments, where providers increase treatment intensity to attract new patients as they become more profitable. Ellis and McGuire explicitly model providers' admission *and* treatment policies as a function of reimbursement, although they do not distinguish between average or marginal reimbursement changes. In contrast, we explicitly model providers' admissions and treatment policies as a function of both marginal and average reimbursement.

Consider first non-profit home health agencies that must choose among *N potential* patients to "admit" for home health services. Home health agencies choose both admissions policies that determines the probability of admitting patient *j* (*p*) and a treatment policy that determines treatment intensity (e.g. the number of home visits) (*c*) for patient *j*, as a function of a fixed payment per patient (*a*) and marginal reimbursement (*m*) for additional services. The assumption of non-profit status means that home health agencies pursue both profits and patient wellbeing. Reflecting this, we assume that home health agencies maximize a utility function that includes the intensity of care (as represented by the probability of admission (p_j) and the intensity of care conditional on admission (c_j) (similar to Hodgkin and McGuire (1994)), as well as expected profits, as in (1):

$$max_{wrt\ p,c} \quad U\left(E\left(\pi\right), \quad p_j, c_j\right) \quad (1)$$

Where expected profits are represented as in (2),

[5]The use of nominal rather than real payments and costs does not substantively affect our estimates in the paper because of our focus on the short time period immediately surrounding these payment reforms combined with the fact that inflation was low over this time period (1.6-3.4 percent). In addition, we control for time trends in the estimation, which captures changes in payments and costs related to inflation. Figure 1 does not control for changes in patient composition, but we do this in the formal analysis.

$$E(\pi) = \sum_{j=1}^{N} p_j \left(a_j + (m_j - 1)\, c_j\right) \quad (2)$$

The first order condition for home health agencies' admission decisions is given in (3):

$$[p_j] : U_{p_j} = -U_\pi \left(a_j + (m_j - 1)\, c_j\right) \quad (3)$$

Equation (3) implies that home health agencies admit patients such that the marginal utility of an increase in admission probability for a patient *j* equals the change in profits from admitting the patient multiplied by the marginal utility of profits. Equation (3) also implies that any patient *j* that is profitable (taking *c* as fixed) will be admitted, assuming no capacity constraints. Any reduction in marginal reimbursement (*m*) or the fixed payment (*a*) will decrease the profitability of patient *j* and lower *j*'s probability of home health admission. This condition predicts that the Home Health IPS, characterized by a reduction in both *a* and *m*, would reduce admissions.

A for-profit agency is assumed to take all patients for whom $E(\pi)$ is positive if there are no capacity constraints. If there are such constraints, the provider takes the most profitable patients until the constraint is binding. Like the nonprofit case, decreases in *a* or *m* will render some marginal patients unprofitable.

The Home Health PPS, however, was characterized by an increase in a fixed payment per 60-day episode, which increased average reimbursement, and a decrease in marginal reimbursement (for 5 or more visits in an episode $m = 0$). Thus, the model offers ambiguous general predictions on the impact of the PPS on patient volume.

Equation (4) shows the first order condition determining home health providers' treatment intensity decision. We assume that an increase in *c* attracts more patients and that the added patients are drawn at random from the same distribution as existing patients.

$$[c_j] : U_c = -U_\pi \left(1 - m_j - E(\pi) \frac{\partial N}{\partial c}\right) \quad (4)$$

This condition implies that providers choose intensity for patient *j* such that the marginal utility of intensity is equal to the change in profits multiplied by the marginal utility of profits. Profits fall with an increase in intensity if marginal reimbursement is less than one. However, increasing intensity will also have a positive effect on profits through an increase in demand for home health services (i.e. admissions) as long as the marginal patient is profitable. A for-profit agency will choose *c* to attract profitable patients subject to a capacity constraint (or a population constraint on profitable patients). Considering these two effects, Equation (4) implies that marginal reimbursement and treatment intensity are positively related. An increase in average reimbursement increases profits which reduces the marginal utility of profits; as a result, average reimbursement and treatment intensity are also positively related. Any competition from other post-acute providers strengthens this relationship. Thus, this condition predicts that the IPS would lead to lower treatment intensity, as marginal and average reimbursement decreased. Again, this condition offers

ambiguous predictions for the PPS. The increase in average reimbursement offsets the decrease in marginal reimbursement, leading to ambiguous effects on treatment intensity.

4. Data

We use two separate samples of patients for analyses of the Home Health IPS and PPS. The sample for the IPS includes patients discharged from acute care between January 1996 and June 1999. The IPS was implemented in October 1997, so this provides seven quarters of discharges before and after the IPS. The sample for the PPS includes patients discharged from acute care between January 1999 and June 2002. The PPS was implemented in October 2000, so this again provides seven quarters of acute discharges before and after the PPS.

The sample consists of patients whose principal diagnosis at acute admission was stroke, lower extremity joint replacement, or hip fracture[6]. By focusing on home health use after hospital discharge, we are not able to observe changes in treatment and patient composition from home health patients without a preceding hospitalization (which was increasing as a share of home health patients over this period (Medpac 2011)). However, this is likely a small share of patients recovering from a recent stroke, hip fracture, or joint replacement (all of which typically require hospitalization). The units of analysis are individual acute discharges, where outcomes are measured over the initial acute stay plus a fixed episode period following the acute discharge. Our main analysis uses a post-acute episode length of 90 days; thus, any acute admission occurring during the 90 days following the acute discharge is labeled an acute readmission. [7]

a. Medicare Payment and Costs

We construct measures of Medicare's payments to home health agencies, and costs incurred by health care providers, using 100% Medicare claims for acute hospitals, home health agencies, inpatient rehabilitation facilities, long term care hospitals, and skilled nursing facilities for hospital discharges from January 1996 through June 2002 linked with provider cost reports. We define Medicare payments to home health providers for each episode-observation as total payments occurring within a 90-day post-acute episode following an initial acute care (hospital) discharge. To measure costs, we multiply the number of visits during a 90-day post-acute episode by a facility's cost per visit (for a given calendar year) obtained from Medicare cost reports. To measure substitution towards other post-acute settings, we use information on admissions and costs of care to inpatient rehabilitation facilities, skilled nursing facilities, and long term care hospitals. Costs are calculated by multiplying charges reported on claims by facility-level cost-to-charge ratios reported on Medicare cost reports [8].

[6]Stroke patients are defined as those with a principal diagnosis in the acute hospital stay of intracerebral hemorrhage (ICD code is 431.xx), occlusion and stenosis of precerebral arteries with infarction (433.x1), occlusion of cerebral arteries with infarction (434.x1), or acute but ill-defined cerebrovascular disease (436.xx). Hip fracture patients are defined as patients with a primary diagnosis of fractures of the neck or the femur (820.xx). Lower extremity joint replacement patients were defined as patients with a primary diagnosis for joint replacement, excluding hip fracture patients and patients with reattachment procedures.

[7]Longer post-acute episodes may capture later unrelated readmissions and subsequent costs, whereas shorter episodes may miss related costs, readmissions, and patient outcome. In analyses not reported, we examine the sensitivity of the results to differing post-acute episode lengths and find similar results.

[8]Medicare-certified health care providers are required to submit cost reports each year with information on costs of providing care, charges to Medicare, and other facility information.

b. Patient Characteristics

We use information from initial acute hospital claims and enrollment files to measure patient characteristics. From the initial acute hospital claim, we construct indicators for the list of comorbidities developed by Elixhauser et al. (1998)[9]. We also control for complications occurring during the initial hospital stay which may affect patients after hospital discharge, drawing from those identified by Iezonni, Daley et al. (1994)[10]. For patients with a primary diagnosis of stroke, we control for hip replacement and whether the stroke was hemorrhagic or ischemic. For patients with a primary diagnosis of hip fracture, we include indicators for partial or total hip replacement (relative to internal fixation or no surgery) and if patients had a stroke. For patients with a primary diagnosis of joint replacement we include indicators of whether patients had a hip replacement, knee replacement, whether replacement was bilateral, if patients had both hip and knee replacements, and if patients had a stroke. We use information from Medicare enrollment files to describe patient demographics including gender, age (indicators for five-year bands), race, and whether beneficiaries are dual-eligible for Medicaid (based on whether they receive Medicaid).

c. Health Outcomes

The services provided by home health providers are focused primarily on improving functional status and rehabilitation, and thus the most appropriate health measures would be assessment data measuring improvements on these outcomes. However, such measures are only available for patients who receive home health services, and our analysis focuses on changes both from intensity of home health services and the probability of receiving any home health care. As a result, we focus on health outcomes that are available for all hospital discharges and are correlated with functional status including mortality during the 90-day episode, and any hospital readmission during the 90-day post-discharge period. However, these are somewhat more extreme health outcomes, and thus we may not detect modest changes in functional status that occur with home health payment reform.

d. Provider characteristics

We also control for characteristics of the hospital for the initial hospitalization preceding a post-acute episode that may influence post-acute outcomes, obtained from Medicare Provider of Services files (a provider level database maintained by the Centers for Medicare and Medicaid Services), cost reports, and Acute Impact files (also providing information on Medicare providers). These measures include ownership status (government, non-profit, or for-profit; from the Provider of Services files), the wage index, the acute case mix index, the resident to average daily census ratio, the Dispropotionate Share (DSH) patient percentage, the number of beds, and the average daily census.

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[9]Comorbidities include AIDS, alcoholism, deficiency anemias, rheumatoid arthritis/ collagen vascular diseases, blood loss anemia, congestive heart failure, chronic pulmonary disease, coagulopathy, depression, diabetes with chronic complications, diabetes without chronic complications, drug abuse, hypothyroidism, liver disease, lymphoma, fluid and electrolyte disorders, metastatic cancer, other neurologic disorders, obesity, paralysis, peripheral vascular disease, psychoses, pulmonary circulation disease, renal failure, solid tumor without metastasis, peptic ulcer disease excluding bleeding, valvular disease, and weight loss.

[10]Complications include post-operative pulmonary compromise; post-operative gastrointestinal hemorrhage; cellulitis or decubitus ulcer; septicemia; pneumonia; mechanical complications due to a device, implant, or graft; shock or arrest in the hospital; post-operative myocardial infarction; postoperative cardiac abnormalities other than AMI; venous thrombosis and pulmonary embolism; procedure-related perforation or laceration; acute renal failure; delirium; dementia; and miscellaneous complications.

e. Exclusions and sample size

We drop episodes of care where patients died during the initial hospital stay. We also dropped episodes of care where Medicare was not the primary payer during the hospital stay, and when patients were enrolled in a Medicare HMO (i.e. Part C) because such episodes produced different financial incentives than fee-for-service Medicare. In addition, we exclude episodes initiating in Maryland hospitals (and Medicare beneficiaries from Maryland) because Maryland hospitals are exempt from Medicare prospective payment systems.

The IPS base sample consists of 980,776, 727,809, and 864,537 episodes of care for stroke, hip fracture, and joint replacement. We dropped approximately one percent of episodes for each condition due to missing data. The PPS base sample includes 908,577, 702,006, and 948,811 episodes of care for stroke, hip fracture, and joint replacement. We dropped one percent of observations for each condition due to missing data. Summary statistics spanning the entire sample period (from 1996 q1 through 2002 q2) are displayed in Table 1 [11].

5. Empirical Approach

Within a home health agency unconditional costs (i.e., across all acute discharges whether or not admitted to a home health agency) can change after a reimbursement change either because of changes in the probability of being admitted (*p*) or changes in costs conditional on being admitted (*c*). In addition, the probability of being admitted and conditional costs are both functions of individual characteristics (*x*).

After payment reform, changes in admission probabilities originate from the admission policies of home health agencies and from changes in the composition of individuals discharged from acute care hospitals. This change can be expressed as:

$$\Delta p_{hha} = p_{hha}^{post}\left(x^{post}\right) - p_{hha}^{pre}\left(x^{pre}\right) \quad (5)$$

where p^{pre} and p^{post} are functions of patient observable characteristics and represent the admission policies of home health agencies pre- and post-payment reform. Similarly, x^{pre} and x^{post} represent the composition of patients discharged from hospitals pre- and post-payment reform[12] .

The goal of our empirical strategy is to disentangle admission policy changes from shifts in the composition of acute discharges. Equation (5) can be rewritten as in (6):

$$\Delta p_{hha} = \left[p_{hha}^{post}\left(x^{pre}\right) - p_{hha}^{pre}\left(x^{pre}\right)\right] + \left[p_{hha}^{post}\left(x^{post}\right) - p_{hha}^{post}\left(x^{pre}\right)\right] \quad (6)$$

[11]As shown in Table 1, conditional costs are higher than conditional payments for stroke patients (and the difference between payments and positive but small for joint replacement and hip fracture patients). This could be due to imprecision from the use of facility (rather than condition) specific costs-per-visit to calculate costs rather than systematically negative margins for facilities seeing stroke patients.

[12]Cost sharing for patients did not change so changes in admission probabilities are unlikely to change from the patient side.

The first term in equation (6) represents the admission policy effect - changes in the probability of admission holding the acute discharge cohort constant. The second term in (6) represents the composition effect - changes in the probability of admission from changes in the characteristics of individuals discharged from acute care hospitals, holding admission policies constant.

We separately estimate the "admission policy" and "composition" effects in equation (6). Our approach is similar to a "simulated instrumental variables" methodology (e.g. Currie and Gruber (1996), Cutler and Gruber (1996)). First, we model home health admissions in each quarter of the data as a function of health, demographic, provider, and geographic characteristics described in the data section above using a probit model, for each quarter *q* of our data in the pre- and post-payment reform periods.

$$prob^q\left(anyHHA=1|x_i\right)=\Phi\left(\alpha^q+\beta^{q'}x_i\right) \quad (7)$$

where *x* is a vector of observable characteristics for person *i*. The separate estimates of α and β for each quarter are then used to construct an "admission simulator." We apply the coefficient estimates from each quarter to a constant cohort of acute-care discharges: for the IPS this quarter is the first quarter of 1996; for the PPS this cohort is from the first quarter of 1999. We create a synthetic panel of simulated admission probabilities, such that the sample is held constant and only the policy rules (as a function of observable characteristics) change.

We then estimate interrupted time-series models as in (8), regressing projected home health probabilities on a linear quarterly trend and indicator variables for the seven quarters following each policy change.

$$p_{it}^q=\alpha+\eta Quarter+\sum_{k=1}^{7}\theta_k Post_k+u_{it} \quad (8)$$

The estimates of θ represent average differences (relative to the counterfactual quarterly time trend) in simulated admissions in each quarter after the policy change for the base cohort.

To estimate the "composition" effect, we apply the "admissions simulator" from the last quarter of each sample (representing the post-IPS/PPS admissions policy period) to each successive cohort of acute discharges. We then estimate equation (8), but this time the estimates of θ represent changes in admissions stemming from changes in the composition of patients discharged from acute hospitals.

Next, we examine changes in costs of patients seen in home health agencies. Changes in costs can result from changes in home health agencies' treatment policies and/or from changes in the composition of individuals admitted to home health agencies. Analogous to equation (6), overall changes in costs after payment reform can be decomposed into a part driven by changes in the treatment policies of providers (treatment effects) and a second part driven by changes in the characteristics of patients admitted to home health agencies

(selection effects). Similar to the approach with admissions, we separately estimate treatment and selection effects. First, we model costs incurred by home health agencies as a function of individual, provider, and geographic characteristics (the same as those used for modeling admission policies) for patients seen in home health agencies separately for each quarter of the sample. We use the coefficient estimates for each quarter to create a "treatment simulator" projecting costs in each quarter of the sample (pre and post-payment policy change) for a fixed cohort of home health patients. We then estimate an interrupted time series model similar to that in equation (8), but now indicating changes in conditional costs due solely to changes in treatment, isolated from changes in patient composition. To estimate the "selection" effect, we apply a treatment simulator from a single and constant quarter to each successive cohort of home health patients. These projected costs only demonstrate changes due to selection, as the treatment simulator is held constant. Again we estimate interrupted time series models, but now the coefficient estimates indicate changes in costs coming from selection.

We separately estimate changes from provider behavior versus patient composition for two reasons. First, inadequately controlling for changes in patient characteristics may lead to inaccurate conclusions about the impacts of a policy; for example, if patients seen by home health agencies are less severe after payment reform and this is not sufficiently controlled for in the estimation, one might inaccurately conclude that reductions in costs are due to reductions in treatment intensity rather than selection. In addition, the fraction of changes in cost or admissions due to the changing composition of patients is itself an important parameter. The approach discussed above both flexibly controls for patient characteristics and quantifies changes in admissions and costs due to both composition and the behavior of home health agencies isolated from changes in patient mix.

If selection occurs on the basis of patient characteristics that we do not observe, then our treatment and admission policy estimates may reflect this unobserved selection rather than treatment policy. However, we include an array of observable clinical and demographic comorbidities and patient characteristics as described above, mitigating concerns of omitted variables. We are limited in variables controlling for patients' economic or financial status; however Medicaid eligibility and coverage may proxy for low socio-economic status.

Changes in admission and treatment policies in home health agencies could potentially impact use of other post-acute services, hospital readmissions, and patient health outcomes. We use a similar empirical strategy to estimate effects on readmission probabilities and patient health outcomes.

Our identification relies on the inclusion of a quarterly time trend to control for secular trends in home health use. To the extent that other events occurred contemporaneously with payment reforms, our estimates may be biased. In sensitivity analysis, we examine differences in home health admissions, costs, and outcomes between hospital service areas experiencing larger and smaller payment changes after the IPS, similar to that in McKnight (2006), allowing for the inclusion of year-quarter fixed effects.

Finally, we investigate heterogeneous changes in costs and admission probabilities across patients with heterogeneous changes in payments. For this, we again create a synthetic panel and regress changes in projected home health costs or admissions (as a function of observable characteristics) on changes in home health payments before and after each payment reform.

The outcome variables in all of the analyses are predicted values that are themselves functions of coefficient estimates from regressions of Medicare payments, provider costs, admissions, and health outcomes on patient and provider characteristics (e.g. α and β from estimating equation 7 in each quarter). Because these coefficient estimates are also measured with error, conventional standard errors may underestimate the true standard error of coefficient estimates. Instead, we obtain pairs-clustered bootstrapped standard errors. We draw hospital referral regions (defined by Dartmouth Medical School (1996)) with replacement from the original sample, simulate the outcome(s) of interest, and then estimate coefficient estimates from the main regressions (e.g. θ_1 through θ_7 in equation 8). We then repeat this process over 500 replications, and the standard estimate is the standard deviation of the coefficient estimate (Cameron, Gelbach et al. 2008).

6. Results

Our results section proceeds as follows. First we examine the effects of payment reforms on Medicare payments to home health agencies, home health agency costs, and admissions. Next, we investigate the presence of "spillover" effects of the IPS and PPS on costs in other post-acute settings and whether there are effects on acute readmissions and health outcomes. We perform sensitivity analyses comparing changes in outcomes in hospital service areas with larger and smaller changes in payment after the IPS. Finally, we investigate the presence of heterogeneous effects of the IPS and the PPS on home health agency costs and admissions by patients with differential changes in average payments.

6.1. Effects of IPS and PPS on home health payments, costs, and admissions

We begin by graphically examining the effects of reimbursement policy changes. Figure 2 shows treatment and admission policy effects of the IPS and PPS for stroke patients. In each case, the solid line represents the mean "simulated" value for each quarter in the synthetic panel, where the patient cohort includes hospital discharges or home health patients from the first quarter of 1996 (for the IPS) or the first quarter of 1999 (for the PPS) and outcomes are simulated for each subsequent quarter, using quarter-specific probit estimates for admission probabilities or OLS estimates for payments and costs. This approach allows us to focus on change due solely to changes in treatment and admissions policies (as a function of patients' observable characteristics), as opposed to changes in the composition of patients in home health agencies or composition of patients discharged from acute care. The dashed line represents a quarterly linear time trend estimated in the pre-policy change period, representing the counterfactual trend in the post-policy change period. Finally, the dotted line represents actual average outcomes in each quarter.

Payments—Figure 2a traces out home health payments before and after the IPS implementation. After remaining constant over the pre-IPS period, average home health

payments fell substantially after the IPS, from over $2,800 to under $2,200 for stroke patients. In contrast, after the Home Health PPS average Medicare payments to home health agencies for stroke patients increased considerably relative to the pre-reform trend (Figure 2b). The first panel of Table 2 displays estimates from regressing simulated payments on indicators for the first seven quarters after the IPS and the PPS, controlling for a quarterly trend. By the second year after the IPS, payments were reduced by over $700; after the PPS, payments had increased by an even greater amount. Appendix Tables A.2 and A.3 present IPS and PPS payment effects for hip fracture and joint patients and exhibit larger PPS effects relative to the IPS effects.

Costs—Figures 2c and 2d show costs simulated in each quarter for a constant cross-section of home health patients before and after the IPS and PPS. Figure 2c shows a reduction in costs after the IPS, from over $3,000 in the first quarter of 1997 to under $2,600 at the end of 1999, mirroring the decline in average payments to home health providers in Figure 2a. However, while average payments increased after the PPS, costs increased only a marginal amount relative to the counterfactual trend (in Figure 2d). The second panel of Table 2 shows this in greater detail. Although the decrease in costs after the IPS was comparable to the decrease in average payment, the increase in costs after the PPS was only around 1/3 of the increase in payments for stroke patients. Appendix Tables A.2 and A.3 exhibit similar patterns for hip fracture and joint replacement.

Admissions—Figures 2e and 2f and the third panel of Table 2 exhibit changes in admissions over the simulated panel. The probability of using home health services decreased over 6 percentage points after the IPS, again coinciding with the decrease in Medicare reimbursement. However, home health admissions decreased further after the PPS for stroke patients, despite the increased average generosity towards home health agencies. Similar patterns are exhibited for hip fracture and joint replacement patients in the third panels of Appendix Tables A.2 and A.3 (with less pronounced reductions in admissions for joint replacement after the PPS).

Figure 2 and Table 2 show that the IPS and PPS had similar magnitude effects on average Medicare payments to home health agencies (with the IPS reducing and the PPS increasing payments); however, while the IPS substantially decreased home health costs and probability of use, the PPS led to smaller increases in costs and actually decreased use of home health (for the three conditions in our sample). These asymmetries may be due to the change in marginal reimbursement under these systems. The IPS decreased both average and marginal reimbursement, while the PPS increased average reimbursement but further decreased marginal reimbursement. These results show the relative importance of average and marginal reimbursement in determining providers' admissions and treatment policies. Although we do not quantify the reduction in marginal reimbursement after the PPS, it may have offset the increased Medicare generosity in determining costs and visits per patient, and more than offset increased payments in the determination of home health agencies' admission policies for stroke, hip fracture, and joint replacement patients.

Selection—Home health costs could also change due to selection; that is, the composition of patients using home health services could change with reimbursement policy. Similarly,

the probability of home health use could change with the composition of patients discharged from acute care hospitals. As explained above, we examine selection by estimating OLS and probit regressions expressing costs and probability of home health use as a function of patient, provider, and geographical characteristics in the last quarter of each sample (1999 q2 for the IPS, 2002 q2 for the PPS), and then apply these coefficient estimates to each home health patient cohort and acute hospital discharge cohort to simulate home health costs and admissions (respectively). In this case, treatment and admission policies are held constant, but the cohorts differ. Thus, changes in costs and admissions are attributable to changes in patient composition. However, Figure 3 and Table 3 (and the similarity between actual and simulated outcomes in Figure 2) imply that changes in patient composition had small effects on Medicare payments and home health costs after both the IPS and the PPS. The third panel of Table 3 shows that the hospital discharge cohorts changed after the IPS and PPS such that beneficiaries were slightly less likely to receive home health services after the IPS and PPS, although the coefficient estimates are of mixed statistical significance after the PPS. Appendix Tables A.4 and A.5 show similarly small selection effects for hip fracture and joint replacement.

These results imply that little “cream skimming” based on observable characteristics occurred in home health agencies. However, if there were changing unobservable characteristics, then our treatment and admission policy estimates may also reflect such selection. However, the fact that we observe little selection occurring based on observable characteristics suggests that unobservable characteristics, which are likely correlated with observable characteristics, also stayed constant over this period.

In Appendix Figure A.1, we examine changes in patient composition more directly by plotting the average number of comorbidities and complications, the fraction of home health patients with three or more comorbidities versus no comorbidities, and two or more complications versus zero complications. We find smooth trends (with some seasonality) in these outcomes in each quarter over the sample period, with little obvious change after either reform.

The estimates thus far have examined changes in composition occurring *within* the three conditions in our sample. Next, we investigate the changes in composition occurring across stroke, hip fracture, and joint replacement patients. Appendix Figure A.2 plots the relative fractions of each condition in home health agencies and implies increases in joint replacement patients relative to hip and stroke patients, but these changes are generally smooth over the sample period. We present selection estimates in Table 4 (and Appendix Figure A.3) that pool acute discharges and home health patients across the three conditions and include main condition effects, and thus exhibit changes in costs and admissions reflecting changes in composition both within and across conditions. These estimates show only small changes in costs and admissions (of mixed direction and statistical significance), implying minimal changes in costs or admissions from changes in composition across these three conditions among acute discharges and home health patients.

6.2. Spillover effects of IPS and PPS on other post-acute costs

The therapy and skilled nursing services offered by home health agencies may be obtained in other post-acute settings. As a result, reimbursement policy changes in home health agencies may affect admissions and resource use in other post-acute settings. We investigate spillover effects of the IPS and PPS on inpatient rehabilitation facilities, skilled nursing facilities, and long term care hospitals. Because we estimated little change in costs or admissions based on patient composition in home health agencies, we estimate changes in treatment intensity and admissions in other post-acute settings but not patient composition. Specifically, we simulate admissions in each quarter for a fixed cohort of acute discharges and costs for a fixed cohort of patients in each post-acute setting (in 1996q1 for IPS, 1999q1 for PPS). Then, we multiply predicted post-acute costs (conditional on use) by the probability of use for each patient observation in the synthetic cohort.

Table 5 displays estimated effects of the Home Health IPS and PPS on simulated costs in other post-acute settings for stroke patients. Table 5, column 1 indicates small and statistically insignificant increases in skilled nursing costs in the first two quarters after the IPS, but the negative coefficients for POST3 through POST7 imply substantial reductions in skilled nursing costs. However, the third and fourth quarter following the IPS includes hospital discharges occurring in the second and third quarters of 1998, immediately preceding and following the implementation of the Skilled Nursing Facility Prospective Payment System in July 1998, which other research has shown had a substantial negative effect on skilled nursing facility utilization and costs (e.g. Grabowski, Afendulis, and McGuire (2011)) [13]. Thus, it seems likely that the large decrease in skilled nursing costs was driven by the skilled nursing prospective payment system. We find no statistically significant change in inpatient rehabilitation or long term care hospital costs after the IPS in columns 2 and 3 of Table 5.

Table 5, column 4 shows increases in skilled nursing facility costs after the Home Health PPS; however, these are likely attributable to the Balanced Budget Refinement Act (BBRA) in April 2000 and the Benefits and Improvement and Protection Act (BIPA) in April 2001, occurring shortly before and after the Home Health PPS and both of which increased Medicare payments to skilled nursing facilities (Grabowski, Afendulis et al. 2011). Table 5, columns 5 and 6 show mostly statistically insignificant reductions in inpatient rehabilitation facility and long term care hospital costs after the Home Health PPS. Appendix Tables A.6 and A.7 show similar patterns of spillover effects for hip fracture and joint replacement patients, except for negative and statistically significant estimates for inpatient rehabilitation after the home health PPS. However, these effects are particularly pronounced for the second year after the reform, which coincides with the Inpatient Rehabilitation Facility Prospective Payment System in January 2002 (which other research has found reduced inpatient rehabilitation costs (e.g., Sood, Huckfeldt et al. (2013)) In summary, we do not find definitive evidence of causal effects of either home health payment reform on other post-acute settings.

[13]Some hospital discharges occurring prior to the SNF PPS may have included episodes that were still partially exposed to the PPS.

6.3. Effects of IPS and PPS on acute readmissions and mortality

Reductions in home health costs and admissions may affect patient health outcomes. To examine this, we estimate the impact of the IPS and PPS on acute readmissions within 90 days following acute discharge and mortality within 90 days of acute discharge. Because we found little evidence of changes in costs or admissions stemming from patient composition, we only simulate changes in outcomes for a constant cohort of patients. Specifically, we estimate the probability of death or readmission in each quarter as a function of observable characteristics, and project the coefficient estimates from each quarter to a constant patient cohort. Figure 4 plots simulated acute readmissions and mortality (within a 90 day post-acute episode in each case) for stroke patients before and after the IPS and PPS. In Tables 6 and 7, we regress simulated outcomes on indicators for calendar quarter (reflecting the seasonality of these measures), calendar quarter interacted with “POST” reform indicators, and a linear time trend. The figures show little change in patient outcomes after each reform. In addition, the POST-quarter interactions are mostly statistically insignificant, and when significant are mixed in direction. While these estimates suggest that there was little effect of either home health payment reform on mortality and readmissions, we cannot rule out effects on more intermediate outcomes such as functional status that we are unable to measure in our data. However, large effects on functional status may be less likely given the strong association between functional status and mortality (Scott, Macera et al. 1997).

6.4. Geographic variation in Home Health IPS

Our main analyses estimate the impacts of payment reform on Medicare payments, costs, admissions, and other outcomes by comparing post-reform changes to a pre-reform linear time trend. For example, following the Home Health IPS, we find sharp breaks in the pre-reform time trend for payments, admissions, and costs, but no break in trends for mortality and readmissions. However, to distinguish the effects of policy impacts from other contemporaneous trends in a definitive fashion, we require exogenous treatment and control groups. While such a control group does not exist (as far as we know) for the Home Health Prospective Payment System, per-patient payment limits for Medicare reimbursement after the Interim Payment System were based in part on an agency's historical average (75%), and in part on the average costs per patient across an agency's census division (25%). Thus, facilities with average per-patient visits above the division average experienced greater reductions in Medicare payment than facilities below the division average[14]. Similarly, patients in geographical areas with facilities that provided, on average, higher than their division's average number of visits were exposed to a greater reduction in payment than patients in geographic areas with facilities below their division's average number of visits.

We construct average visits per 90-day post-discharge episode across stroke, hip fracture, and joint replacement patients at the hospital service areas (defined by Dartmouth (1996)) and at the census division level. Then, we plot simulated payments, costs, home health admissions, hospital readmissions, mortality, and skilled nursing facility costs separately for stroke patients in hospital service areas that are above and below their respective census division means in Figure 5. In this case, we simulate payments, costs, home health

[14]McKnight (2006) exploits this variation to examine home health utilization after the IPS.

admissions, and outcomes in each quarter separately for two base cohorts of patients (acute discharges in 1996 q1) living in hospital service areas with average numbers of visits above and below their census division average[15]. The identifying variation comes from differential changes in admission and treatment policies in hospital service areas that were above versus below their census division average number visits prior to the reform.

Figure 5 shows a narrowing of home health payments after the IPS in the above and below division mean hospital service areas (for stroke patients), although the common payment reduction is larger than the differential change. Figures 5b-f shows that this narrowing also occurs for home health costs, but not for the probability of home health use, hospital readmission, mortality, or skilled nursing facility costs. Estimates from difference-in-difference regressions, comparing changes in outcomes in hospital service areas with above division mean visits compared to hospital service areas with below division mean visits are displayed in Table 8. These specifications are similar to that in equation (8), except that the post indicators are interacted with an “above division mean” indicator variable and we include time (year-quarter) fixed effects instead of a quarterly trend.

Table 8 columns 1 and 2 show that the decrease in payments and costs ranges between $140 and $330 larger for patients in above-division-mean hospital service areas (where the total average reduction in payments was over $700 for stroke patients). As implied in Figure 5, there are only small and mostly statistically insignificant effects on home health admissions, acute readmissions, mortality, and other post-acute costs during the 90-day episode. Appendix Tables A.8 and A.9 show similar patterns for hip fracture and joint replacement patients. These estimates imply that reductions in treatment intensity did not increase readmission rates and mortality. In particular, we find little differential change in skilled nursing facility costs, potentially reinforcing that the large and statistically significant effects in the interrupted time series regressions were driven by skilled nursing facility payment reforms.

One potential concern with this estimation is that hospital service areas with above-division average visits in 1996 may exhibit different pre-reform time trends than hospital service areas with below-division average visits, and this may lead to biased estimates. We test for the presence of differential pre-reform time trends by including indicator variables for the two quarters prior to the interim payment system interacted with being above the division average. In this specification, the pre- and post-reform effects are relative to the first two quarters of 1996. Results for stroke are displayed in Appendix Table A.10. In the last row of the table, we display the p-value for testing the hypothesis that *both* the above division pre-reform interactions are equal to zero. In each case with the exception of mortality, we do not reject that both pre-reform indicators are equal to zero (at the 5 percent level). Even for mortality, the coefficient estimate for the quarter prior to reform is not significantly different from zero. In summary, these results imply little evidence of differential pre-trends for hospital service areas with above- versus below-division average visits in 1996.

[15]A small number of hospital service areas have no home health agencies, as a result approximately 8 percent of observations are dropped for these analyses.

6.5. Heterogeneous effects

To investigate the relative importance of average versus marginal reimbursement, we investigate heterogeneity in the effects of reform by average payment change. While changes in overall payments after reforms may vary across patients, changes in marginal payments are more homogenous across patients. Thus, to the extent that changes in average payments are related to changes in admissions or costs, this may reflect the effects of average, as opposed to marginal, reimbursement on provider behavior. If changes in costs and admissions are not related to the changes in average payment, this may signal uniform changes in intensity and volume related to changes in marginal reimbursement.

In Tables 9 and 10, we again create a synthetic patient panel and regress per-patient simulated changes in home health costs and admissions as a function of changes in simulated home health payments, in each case between 1996 quarter 1 and 1999 quarter 2 (for the IPS) and between 1999 quarter 1 and 2002 quarter 2 (for the PPS). In the first panel of Table 9, we find mixed effects of payment changes on the probability of home health use across patients discharged from hospitals after a primary diagnosis of stroke, hip fracture, or joint replacement after the IPS. However, the second and third panels show that changes in payments are positively related to changes in conditional and unconditional costs. In Table 10, we show similarly mixed effects on probability of admission after the PPS, again with strong positive relationships between payments and costs. This result implies that patients exhibiting the largest increases in payments after the PPS received the largest increase in treatment intensity (costs). Thus, these estimates imply that average payments are an important determinant of treatment intensity, but are less strongly associated with admissions.

7. Conclusion

In this paper we examined the effects of changes in Medicare reimbursement for home health agencies, including the Interim Payment System (IPS) in 1997 and the Prospective Payment System (PPS) in 2000. We expanded upon previous research by creating a unified framework to contrast these two unique changes in payment policy: one reducing both marginal and average reimbursement, the other increasing average reimbursement while reducing marginal reimbursement. We developed a conceptual model that predicts the decreases in both marginal and average reimbursement characterizing the IPS will lower both the volume of patients in home health agencies and intensity of treatment, but that offers ambiguous predictions for the PPS due to offsetting positive changes in average reimbursement but further reductions in marginal reimbursement. We employed an empirical approach that separates changes in costs and admissions due to home health agencies' admissions and treatment policies, and those due to the composition of patients discharged from acute care hospitals and admitted to home health agencies. We examined the impacts of the IPS and the PPS on other post-acute settings, acute readmissions, and mortality. Finally, we investigated the presence of heterogeneous effects based on differential changes in average reimbursement, to gauge the relative importance of marginal and average reimbursement.

Consistent with our conceptual model, our estimates showed that the IPS decreased home health costs and admissions. However, despite the substantial increase in reimbursement offered by the PPS, costs (resource use) increased only slightly and admissions actually decreased for the three conditions (stroke, hip fracture, and joint replacement) in our sample. For both the IPS and the PPS, we found little evidence of "cream skimming" based on the observable characteristics in our data. Both payment reforms had limited effects on costs in other post-acute settings, hospital readmissions, and mortality. However, it may be the case that more intermediate outcomes such as functional gain not observable in our data were affected by changes in treatment intensity and admission policies. Changes in per-patient average reimbursement did predict resource use, and to a lesser extent probability of admissions. However, in the PPS, increases in average reimbursement were almost totally offset by reductions in marginal reimbursement with respect to treatment intensity, and changes in marginal reimbursement completely offset increased average reimbursement with respect to admissions, implying that provider behavior may be more responsive to reimbursement at the margin.

Our findings on the IPS are consistent with those of McKnight (2006), who found large reductions in home health utilization with little effect on health outcomes. McKnight also found that the reductions in visits were concentrated among patients with high predicted costs; presumably by focusing recent hospital discharges for stroke, hip fracture, and joint replacement, the patients in our sample correspond to the "high" predicted cost patients in McKnight's sample. In addition, estimates from the PPS showing offsetting effects of reduced marginal reimbursement and increased average reimbursement on resource use are consistent with research examining the inpatient rehabilitation facility prospective payment system (Sood, Buntin et al. 2008, Sood, Huckfeldt et al. 2013). Other research shows that between 2002 and 2009 home health agencies adopted a more nuanced response to the expected service utilization portion of the prospective payment, and were more likely to target the therapy visit threshold to maximize payment and also increased the number of 60-day episodes (Medpac 2011). Still, intensity (measured by average visits per home health patient) stayed well below their pre-IPS levels (Medpac 2010).

Our results suggest that reforms such as bundled payment and accountable care organizations that further reduce marginal reimbursement are likely to impact provider behavior. However, the level of payment is also important; if increased, reductions in resource use will translate to higher margins for providers (as in the PPS) rather than savings to Medicare (as in the IPS).

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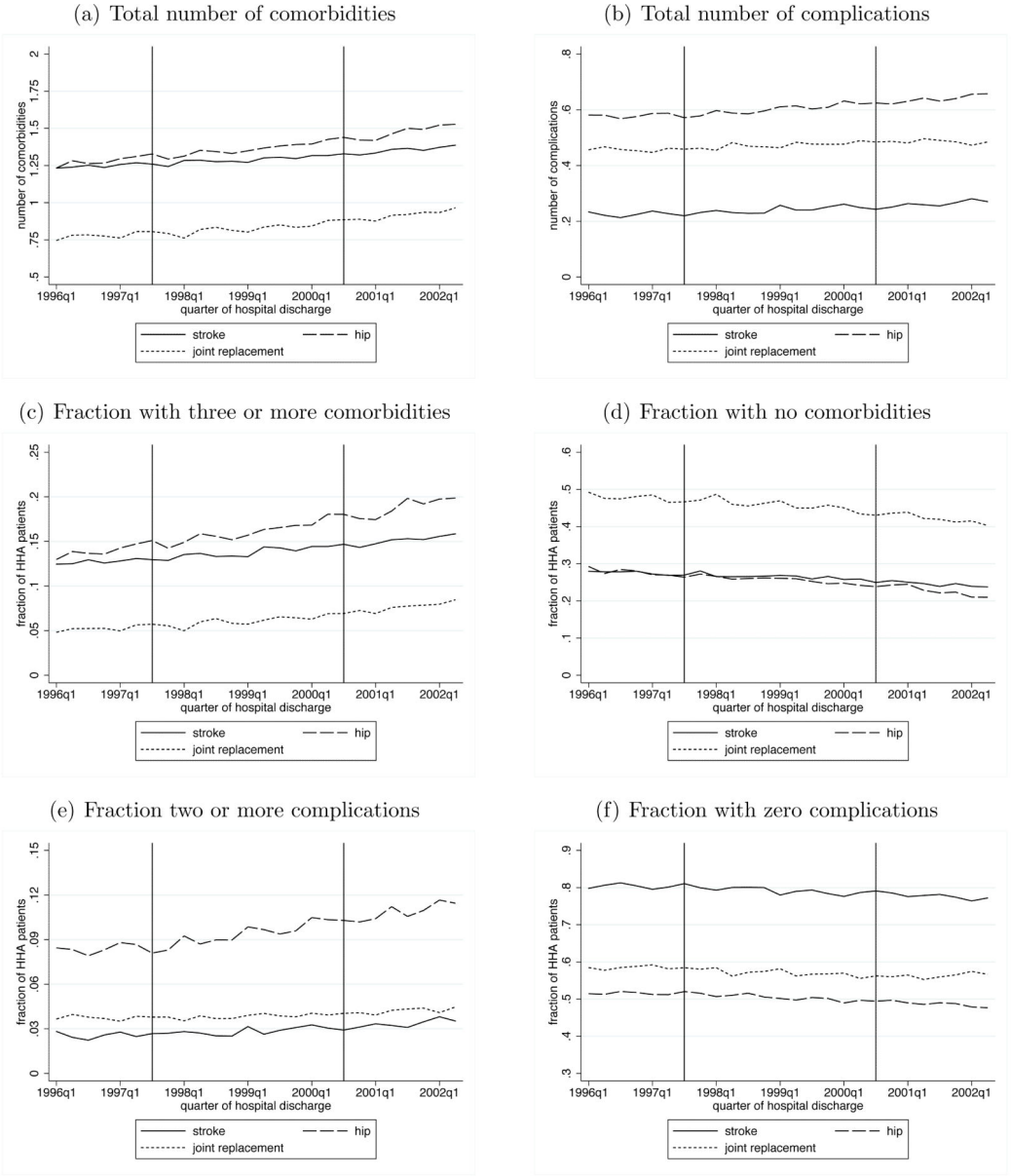
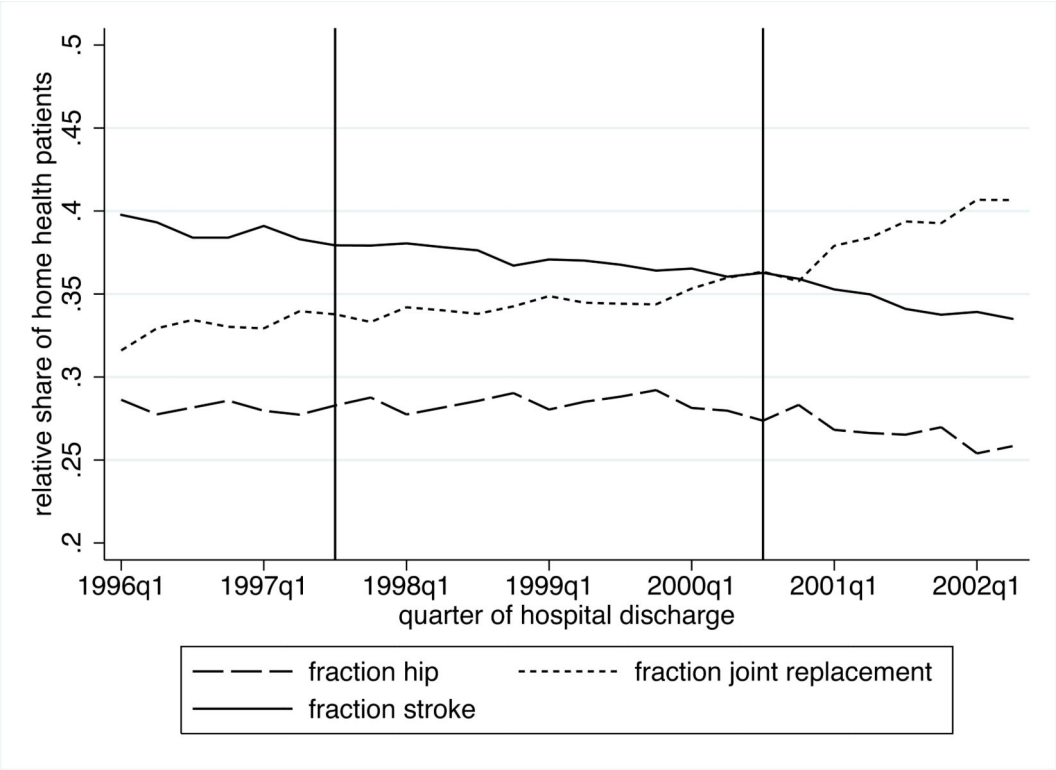
Appendix



Measures calculated from 100% Medicare Home Health claims data. Lines indicate average number of comorbidities and complications for patients in home health discharged from the hospital after stroke (solid line), hip fracture (dashed line), and lower extremity joint replacement (dotted line). Vertical line in IPS graphs indicates quarter prior to Interim Payment System implementation, for PPS graphs quarter prior to Prospective Payment System implementation.

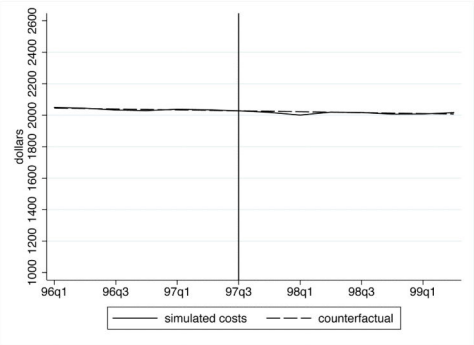
Figure A.1.
Comorbidities and complications of home health patients



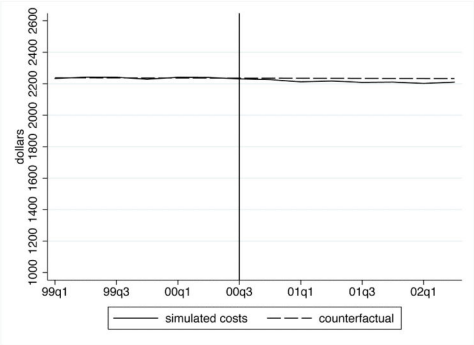
Notes: Figure exhibits the fraction of home health admissions for each study condition as a fraction of total hip fracture, stroke, and lower extremity joint replacement admissions in each quarter. The first vertical line indicates the quarter prior to the Interim Payment System (October 1997) and the second vertical line indicates the quarter prior to the Prospective Payment System (October 2000).

Figure A.2.
Relative share of each study condition in home health patients within sample period

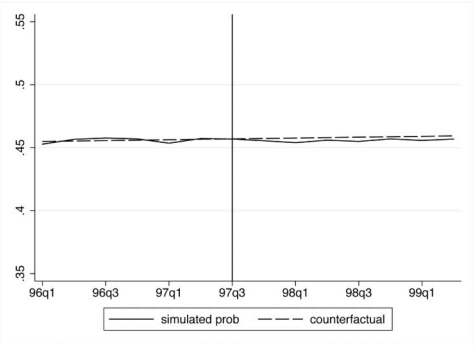
(a) IPS: 99q2 HH payments simulated for each HH cohort



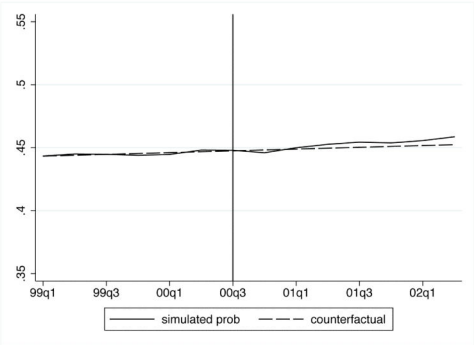
(b) PPS: 02q2 HH payments simulated for each HH cohort



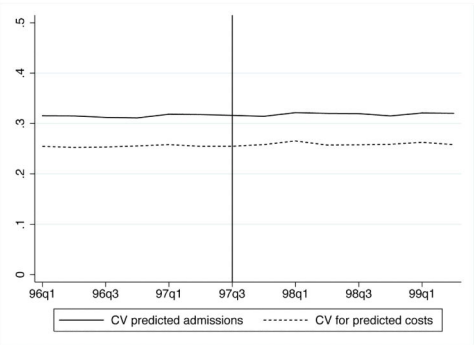
(c) IPS: 99q2 HH costs simulated for each HH cohort



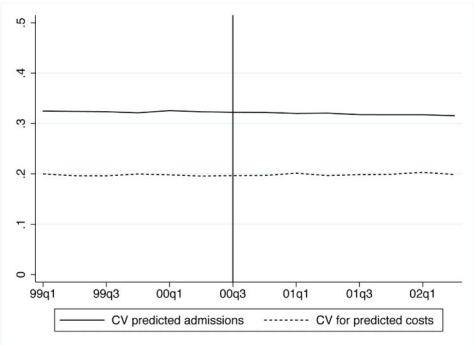
(d) PPS: 02q2 HH costs simulated for each HH cohort



(e) IPS: Coef of var for simulated costs and admissions



(f) PPS: Coef of var for simulated costs and admissions



Note: Measures calculated from 100% Medicare Home Health claims data. Solid line indicates average simulated measures for each quarter. Dashed line indicates pre-IPS or PPS trend. Vertical line in IPS graphs indicates quarter prior to Interim Payment System implementation, for PPS graphs quarter prior to Prospective Payment System implementation.

Figure A.3.

Selection e ects for treatment and admissions for Home Health (HH) Interim Payment System (IPS) and Prospective Payment System (PPS), pooled across hospital discharges for stroke, hip fracture, and lower extremity joint replacement

Table A.1

Summary of Medicare payment of home health agencies over sample period

	Cost-based reimbursement	Interim Payment System	Prospective Payment System
Dates	**January 1996- October 1997**	**October 1997-September 2000**	**October 2000-June 2002**
Marginal reimbursement	Cost-based with per-visit limits	Cost-based with per-visit and (annual) per-patient limits	Prospective payment for 60-day episode
Average payment (stroke)	$2,871	$2,283	$3,235
Average payment (hip fracture)	$2,498	$2,005	$3,287
Average payment (joint replacement)	$1,705	$1,420	$2,759

Notes: Average payment is conditional on any home health, and represents total payments over 90-day post-discharge period.

Table A.2

Treatment and admission policy estimates: effects of Home Health Interim Payment System (IPS) and Prospective Payment System (PPS) on home health payments, costs, and admissions for patients discharged from the hospital after a stroke

	(1) Medicare HH payments		(2) HH provider costs		(3) Home health admissions	
	IPS	PPS	IPS	PPS	IPS	PPS
POST1	−137*** (20)	933*** (21)	−90*** (22)	91*** (22) (17)	−0.024*** (0.003)	−0.023*** (0.003)
POST2	−268*** (24)	963*** (20)	−158*** (26)	184*** (20)	−0.074*** (0.003)	−0.015*** (0.003)
POST3	−392*** (28)	896*** (26)	−313*** (27)	129*** (25)	−0.049*** (0.004)	−0.021*** (0.004)
POST4	−548*** (36)	960*** (25)	−481*** (32)	155*** (24)	−0.058*** (0.004)	−0.028*** (0.004)
POST5	−562*** (39)	1,013*** (27)	−451*** (35)	277*** (29)	−0.055*** (0.005)	−0.023*** (0.005)
POST6	−525*** (43)	917*** (30)	−381*** (38)	312*** (31)	−0.047*** (0.005)	−0.028*** (0.005)
POST7	−529*** (44)	825*** (35)	−422*** (39)	269*** (34)	−0.045*** (0.005)	−0.029*** (0.005)
Time trend	−9*** (3)	56*** (3)	−5* (3)	−6** (3)	0.001 (0.000)	0.004*** (0.001)
Observations	370,146	301,042	370,146	301,042	759,794	706,440
R^2	0.274	0.795	0.171	0.076	0.019	0.002
Dep var mean	2,254	2,616	2,492	2,286	0.462	0.432

Notes Estimates from regression of simulated payments, costs, or admissions on quarterly indicators POST1-POST7 and quarterly trend. Index cohort is 96q1 patients for IPS, 99q1 patients for PPS. Standard errors calculated from 500 block bootstrap replications.

*** indicates significant at 1 percent level

** 5 percent

* 10 percent.

Table A.3

Treatment and admission policy estimates: effects of Home Health Interim Payment System (IPS) and Prospective Payment System (PPS) on home health payments, costs, and admissions, patients discharged from hospital after joint replacement

	(1) Medicare HH payments		(2) HH provider costs		(3) Home health admissions	
	IPS	PPS	IPS	PPS	IPS	PPS
POST1	−49*** (12)	1,033*** (15)	−40*** (13)	77*** (12)	−0.015*** (0.002)	−0.022*** (0.003)
POST2	−162*** (15)	1,057*** (17)	−71*** (16)	198*** (12)	−0.048*** (0.004)	−0.006 (0.004)
POST3	−212*** (17)	1,068*** (18)	−136*** (18)	171*** (14)	−0.052*** (0.004)	−0.020*** (0.004)
POST4	−264*** (20)	1,092*** (18)	−190*** (20)	175*** (15)	−0.065*** (0.005)	−0.020*** (0.005)
POST5	−297*** (23)	1,171*** (22)	−213*** (22)	218*** (18)	−0.071*** (0.005)	−0.007 (0.005)
POST6	−280*** (27)	1,141*** (21)	−151*** (25)	272*** (21)	−0.056*** (0.006)	0.004 (0.005)
POST7	−293*** (27)	1,084*** (23)	−198*** (26)	258*** (22)	−0.070*** (0.006)	−0.001 (0.006)
Time trend	−7*** (2)	39*** (2)	−4** (2)	3 (2)	0.000 (0.001)	−0.002*** (0.001)
Observations	557,564	535,178	557,564	535,178	842,449	880,096
R^2	0.137	0.827	0.052	0.127	0.089	0.020
Dep var mean	1,550	2,058	1,696	1,668	0.637	0.581

Notes * 10 percent. Estimates from regression of simulated payments, costs, or admissions on POST1-POST7 and quarterly trend. Index cohort is 96q1 patients for IPS, 99q1 patients for PPS. Standard errors calculated from 500 block bootstrap replications.

*** indicates significant at 1 percent level

** 5 percent

Table A.4

Selection estimates: effects of Home Health Interim Payment System (IPS) and Prospective Payment System (PPS) on home health payments, costs, and admissions, patients discharged from hospital after hip fracture

	(1) Medicare HH payments		(2) HH provider costs		(3) Home health admissions	
	IPS	PPS	IPS	PPS	IPS	PPS
POST1	−6** (3)	−6 (4)	−9** (4)	−10** (4)	0.007*** (0.001)	0.007*** (0.001)
POST2	2 (4)	−1 (5)	2 (4)	−8 (6)	−0.004*** (0.001)	0.007*** (0.002)
POST3	6 (4)	4 (6)	6 (4)	−2 (7)	0.000 (0.001)	0.005*** (0.002)
POST4	−1 (4)	−1 (6)	−3 (5)	−5 (8)	0.001 (0.002)	0.003** (0.002)
POST5	−2 (5)	2 (7)	−6 (6)	−4 (8)	0.010*** (0.002)	0.009*** (0.002)
POST6	14** (6)	16** (8)	13* (7)	8 (9)	−0.000 (0.002)	0.006*** (0.002)
POST7	14** (6)	15* (9)	12* (7)	8 (10)	0.002 (0.002)	0.008*** (0.002)
Time trend	−1 (1)	1 (1)	0 (1)	1 (1)	−0.001*** (0.000)	−0.001*** (0.000)
Observations	328,000	301,098	328,000	301,098	719,761	695,898
R^2	0.000	0.001	0.000	0.001	0.001	0.000
Dep var mean	1,877	3,342	2,202	2,417	0.439	0.443

Notes Estimates from regression of simulated payments, costs, or admissions on quarterly indicators POST1-POST7 and quarterly trend. Treatment and admission functions for each patient cohort are estimated using 99q2 patients for IPS, and 02q2 patients for PPS. Standard errors calculated from 500 block bootstrap replications.

*** indicates significant at 1 percent level

** 5 percent

* 10 percent.

Table A.5

Selection estimates: effects of Home Health Interim Payment System (IPS) and Prospective Payment System (PPS) on home health payments, costs, and admissions, patients discharged from hospital after joint replacement

	(1) Medicare HH payments		(2) HH provider costs		(3) Home health admissions	
	IPS	PPS	IPS	PPS	IPS	PPS
POST1	−16*** (3)	−16*** (2)	−20*** (3)	−18*** (2)	−0.005*** (0.001)	−0.006*** (0.001)
POST2	−25*** (4)	−21*** (3)	−28*** (4)	−32*** (3)	−0.004*** (0.001)	−0.007*** (0.001)
POST3	1 (3)	1 (5)	0 (3)	−7 (5)	0.002** (0.001)	−0.002 (0.001)
POST4	−3 (4)	−8** (4)	−5* (3)	−14*** (4)	0.001 (0.001)	−0.004*** (0.001)
POST5	−21*** (4)	−19*** (5)	−27*** (4)	−27*** (5)	−0.005*** (0.001)	−0.008*** (0.001)
POST6	−15*** (5)	−16*** (5)	−21*** (4)	−36*** (5)	−0.001 (0.002)	−0.008*** (0.002)
POST7	−2 (5)	1 (6)	−8 (6)	−17*** (6)	0.003 (0.002)	−0.003* (0.002)
Time trend	1 (1)	2** (1)	2** (1)	3*** (1)	−0.000 (0.000)	0.001*** (0.000)

	(1) Medicare HH payments		(2) HH provider costs		(3) Home health admissions	
	IPS	**PPS**	**IPS**	**PPS**	**IPS**	**PPS**
Observations	546,164	548,183	546,164	548,183	857,411	941,139
R^2	0.001	0.001	0.001	0.001	0.001	0.001
Dep var mean	1,327	2,856	1,557	1,860	0.596	0.576

Notes Estimates from regression of simulated payments, costs, or admissions on POST1-POST7 and quarterly trend. Index cohort is 96q1 patients for IPS, 99q1 patients for PPS. Standard errors calculated from 500 block bootstrap replications.

*** indicates significant at 1 percent level

** 5 percent

* 10 percent.

Table A.6

Spillover estimates: effects of Home Health Interim Payment System (IPS) and Prospective Payment System (PPS) on costs in skilled nursing facilities, inpatient rehabilitation facilities, and long term care hospitals, patients discharged from hospital after hip fracture

	Home Health IPS			Home Health PPS		
	(1) Skilled nursing	(2) Inpatient rehab	(3) Long term care hosp	(4) Skilled nursing	(5) Inpatient rehab	(6) Long term care hosp
POST1	−30 (63)	−49 (39)	13 (17)	146** (65)	−261*** (43)	−20 (24)
POST2	290 (184)	34 (56)	27 (19)	522*** (80)	−163*** (43)	50 (33)
POST3	−229 (153)	9 (66)	−3 (24)	584*** (87)	−170*** (55)	35 (30)
POST4	−840*** (123)	103 (70)	−5 (21)	711*** (104)	−194*** (67)	45 (40)
POST5	−1,635*** (227)	88 (75)	37 (32)	919*** (108)	−295*** (71)	65 (42)
POST6	−2,335*** (179)	109* (66)	62* (34)	1,106*** (126)	−385*** (82)	44 (50)
POST7	−2,533*** (213)	141* (80)	96** (45)	1,181*** (136)	−445*** (89)	−7 (50)
Time trend	168*** (13)	6 (8)	1 (3)	−19 (14)	63*** (8)	9** (4)
Observations	759,788	759,770	754,619	706,440	706,425	704,458
R^2	0.059	0.003	0.010	0.034	0.007	0.013
Dep var mean	8,071	2,236	168	7,574	2,567	323

Notes Estimates from regression of simulated payments, costs, or admissions on quarterly indicators POST1-POST7 and quarterly trend. Index cohort is 96ql patients for IPS, 99ql patients for PPS. Standard errors calculated from 500 block bootstrap replications.

*** indicates significant at 1 percent level

** 5 percent

* 10 percent.

Table A.7

Spillover estimates: effects of Home Health Interim Payment System (IPS) and Prospective Payment System (PPS) on costs in skilled nursing facilities, inpatient rehabilitation facilities, and long term care hospitals, patients discharged from hospital after joint replacement

	Home Health IPS			Home Health PPS		
	(1) Skilled nursing	(2) Inpatient rehab	(3) Long term care hosp	(4) Skilled nursing	(5) Inpatient rehab	(6) Long term care hosp
POST1	−9 (27)	−35 (25)	8 (8)	21 (31)	−144*** (29)	−4 (7)
POST2	57 (52)	−86** (38)	9 (10)	122*** (41)	−101** (40)	8 (8)
POST3	−35 (51)	−66* (39)	11 (11)	135*** (42)	−107** (47)	15* (9)
POST4	−140* (74)	−36 (45)	22* (12)	149*** (47)	−93* (53)	24** (11)
POST5	−426*** (54)	−153*** (53)	15 (12)	162*** (52)	−281*** (58)	14 (12)
POST6	−579*** (67)	−173*** (57)	25 (17)	263*** (61)	−329*** (68)	1 (12)
POST7	−683*** (76)	−133** (63)	32** (15)	317*** (65)	−326*** (73)	11 (13)
Time trend	65*** (6)	30*** (7)	−1 (1)	−24*** (7)	63*** (7)	3*** (1)
Observations	842,448	842,440	823,274	880,096	880,096	874,337
R^2	0.012	0.004	0.004	0.001	0.016	0.008
Dep var mean	2,166	2,066	42	2,017	2,446	78

Notes Estimates from regression of simulated payments, costs, or admissions on quarterly indicators POST1-POST7 and quarterly trend. Index cohort is 96ql patients for IPS, 99ql patients for PPS. Standard errors calculated from 500 block bootstrap replications.

*** indicates significant at 1 percent level

** 5 percent

* 10 percent.

Table A.8

Difference-in-difference estimates for IPS, hospital service areas above and below division mean number of visits, patients discharged from hospital after hip fracture

	Home health utilization			Patient outcomes		Other post-acute costs		
	(1) Payments	(2) Costs	(3) Admissions	(4) Readmission	(5) Mortality	(6) Skilled nursing	(7) Inpatient rehab	(8) LTCH
Above x POST1	−129*** (35)	−142*** (41)	−0.003 (0.005)	0.003 (0.004)	0.000 (0.003)	1 (114)	−53 (63)	15 (33)
Above x POST2	−88** (44)	−104** (49)	−0.006 (0.006)	−0.007 (0.005)	−0.001 (0.003)	−275 (220)	126 (112)	69** (33)
Above x POST3	−188*** (44)	−217*** (48)	−0.011* (0.006)	−0.008* (0.005)	−0.002 (0.003)	186 (205)	66 (116)	5 (61)
Above x POST4	−254*** (41)	−275*** (45)	−0.009 (0.006)	−0.002 (0.005)	0.001 (0.003)	−103 (153)	169 (110)	10 (31)
Above x POST5	−289*** (48)	−288*** (50)	−0.003 (0.006)	−0.009* (0.005)	−0.005 (0.003)	−741 (468)	145 (99)	−38 (37)
Above x POST6	−271*** (47)	−279*** (49)	−0.002 (0.006)	−0.010** (0.005)	−0.001 (0.004)	−228 (190)	−5 (106)	29 (39)
Above x POST7	−242*** (48)	−233*** (51)	−0.001 (0.006)	−0.003 (0.005)	−0.004 (0.003)	−243 (173)	105 (111)	48 (52)
Observations	342,482	342,482	703,542	703,556	703,556	703,540	703,476	685,470
R^2	0.615	0.538	0.115	0.102	0.070	0.260	0.270	0.078
Dep var mean	2,259	2,497	0.463	0.226	0.111	8,091	2,256	178

Notes Estimates of regression of simulated payments, costs, and admissions on indicators for POST1 through POST7 interacted with above division mean visits indicator, hospital service area fixed effects, and quarter fixed effects. Index cohort is 96ql acute discharges. Standard errors calculated from 500 block bootstrap replications.

*** indicates significant at 1 percent level

** 5 percent

* 10 percent.

Table A.9

Difference-in-difference estimates for IPS, hospital service areas above and below division mean number of visits, patients discharged from hospital after joint replacement

	Home health utilization			Patient outcomes		Other post-acute costs		
	(1) Payments	(2) Costs	(3) Admissions	(4) Readmission	(5) Mortality	(6) Skilled nursing	(7) Inpatient rehab	(8) LTCH
Above x P0ST1	−28* (17)	−7 (18)	−0.012** (0.005)	0.001 (0.003)	0.002* (0.001)	84 (53)	−27 (48)	9 (41)
Above x POST2	−74*** (23)	−68*** (22)	−0.003 (0.007)	−0.003 (0.004)	0.000 (0.001)	35 (73)	−71 (69)	−2 (197)
Above x POST3	−108*** (23)	−105*** (23)	−0.005 (0.006)	−0.003 (0.003)	0.001 (0.001)	−20 (73)	−49 (83)	−6 (510)
Above x POST4	−130*** (27)	−127*** (26)	−0.005 (0.007)	−0.004 (0.003)	−0.000 (0.001)	1 (81)	−56 (73)	2 (274)
Above x POST5	−130*** (30)	−108*** (28)	−0.006 (0.007)	0.003 (0.003)	0.003*** (0.001)	57 (59)	−58 (94)	6 (63)
Above x POST6	−162*** (28)	−158*** (26)	−0.004 (0.007)	−0.005* (0.003)	−0.001 (0.001)	46 (69)	−121 (88)	1 (92)
Above x POST7	−137*** (30)	−152*** (27)	0.001 (0.007)	−0.004 (0.004)	−0.001 (0.001)	62 (67)	62 (95)	−8 (37)
Observations	516,894	516,894	779,953	779,968	779,968	779,968	779,968	779,968
R^2	0.447	0.351	0.447	0.063	0.046	0.111	0.314	0.030
Dep var mean	1,552	1,697	0.638	0.120	0.008	2,166	2,074	41

Notes Estimates of regression of simulated payments, costs, and admissions on indicators for POST1 through POST7 interacted with above division mean visits indicator, hospital service area fixed effects, and quarter fixed effects. Index cohort is 96ql acute discharges. Standard errors calculated from 400 block bootstrap replications.

*** indicates significant at 1 percent level

** 5 percent

* 10 percent.

Table A.10

Difference-in-difference estimates for IPS allowing for pre-effects, patients discharged from hospital after stroke

	Home health utilization			Patient outcomes		Other post-acute costs		
	(1) Payments	**(2) Costs**	**(3) Admissions**	**(4) Readmission**	**(5) Mortality**	**(6) Skilled nursing**	**(7) Inpatient rehab**	**(8) LTCH**
Above x PRE2	−10 (39)	7 (39)	−0.006 (0.004)	0.005 (0.004)	0.008*** (0.003)	−146 (125)	87 (85)	14 (37)
Above x PRE1	30 (37)	66* (39)	0.005 (0.004)	0.005 (0.004)	0.004 (0.003)	−155 (102)	125* (68)	8 (34)
Above x POST1	−153*** (48)	−137*** (53)	−0.006 (0.005)	0.001 (0.005)	−0.002 (0.003)	−137 (106)	21 (75)	38 (45)
Above x POST2	−179*** (51)	−131** (51)	−0.001 (0.005)	0.003 (0.004)	−0.000 (0.003)	−119 (129)	68 (99)	45 (38)
Above x POST3	−205*** (48)	−203*** (51)	−0.005 (0.005)	0.004 (0.004)	0.003 (0.003)	168 (179)	49 (80)	55 (40)
Above x POST4	−288*** (50)	−280*** (51)	−0.002 (0.005)	0.003 (0.005)	0.005 (0.003)	−239 (160)	86 (110)	66* (34)
Above x POST5	−292*** (55)	−278*** (55)	−0.003 (0.005)	0.003 (0.004)	0.006* (0.003)	−60 (129)	137 (102)	86** (42)
Above x POST6	−327*** (53)	−321*** (53)	−0.006 (0.006)	−0.008* (0.004)	−0.003 (0.003)	−120 (164)	57 (100)	53 (43)
Above x POST7	−287*** (58)	−302*** (60)	−0.004 (0.005)	−0.004 (0.004)	−0.002 (0.003)	−111 (174)	146 (139)	97** (49)
Observations	409,920	409,920	975,654	975,688	975,688	975,640	975,604	970,869
R^2	0.623	0.550	0.268	0.129	0.051	0.136	0.136	0.050
Dep var mean	2,595	2,875	0.387	0.269	0.147	5,263	3,415	281
Pre-trend test p-value	0.697	0.235	0.140	0.234	0.009	0.159	0.109	0.906

Notes Estimates of regression of simulated payments, costs, and admissions on indicators for PRE1, PRE2, POST1 through POST7 interacted with above-division mean visit indicator, hospital service area fixed effects, and quarter fixed effects. Index cohort is 96ql acute discharges. Standard errors calculated from 500 block bootstrap replications.

*** indicates significant at 1 percent level

** 5 percent

* 10 percent.

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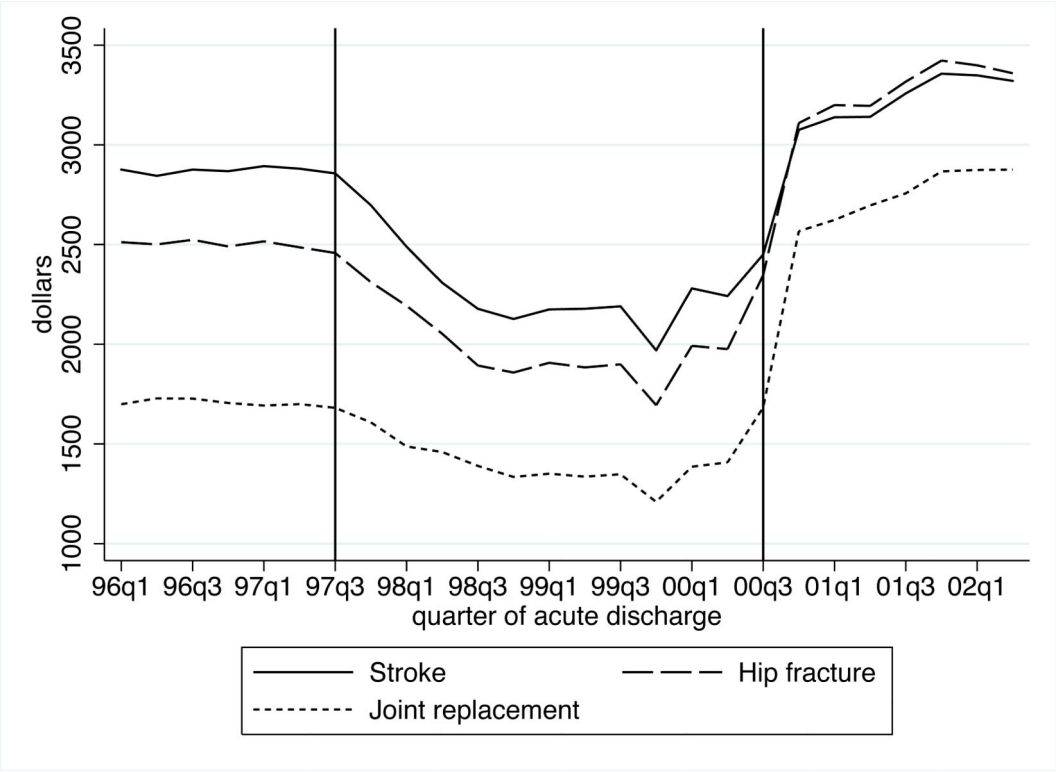
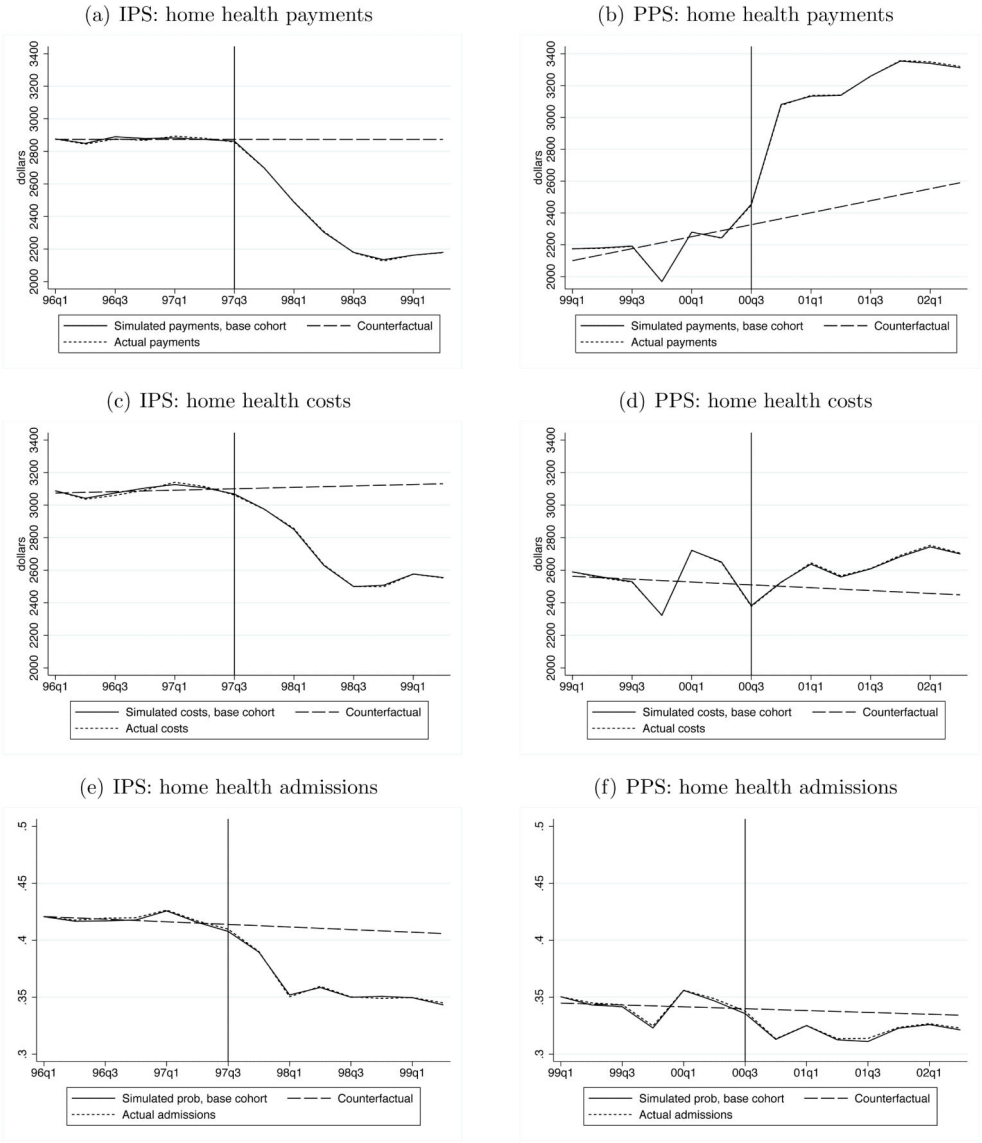


Note: Figure shows average Medicare fee-for-service payments to home health agencies in the 90-days following hospital discharges occurring each quarter between 1996q1 and 2002q2 separately for patients discharged from the hospital after a stroke, hip fracture, or joint replacement. The first vertical line indicates quarter before Home Health IPS (10/1997). The second vertical line indicates the quarter prior to the Home Health PPS (10/2002).

Figure 1.
Average Medicare home health payments conditional on use

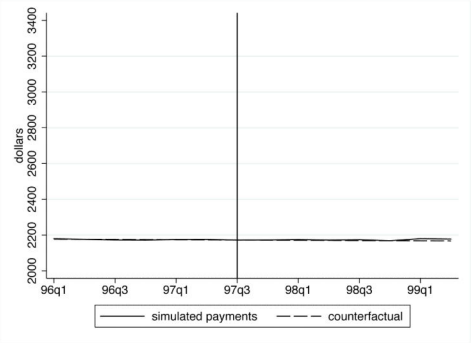


Note: Measures calculated from 100% Medicare Home Health claims data. Solid line indicates average simulated measures for each quarter. Dashed line indicates pre-IPS or PPS trend. Dotted line indicates actual means. Base cohort for IPS simulated values includes home health patients discharged from acute care for stroke in the first quarter of 1996 (for payments and costs) and all acute discharges for stroke (for admissions). Base cohort for PPS simulated values includes home health patients discharged from the hospital after a stroke in the first quarter of 1999 (for payments and costs) and all acute discharges after stroke (for admissions). Vertical line in IPS graphs indicates quarter prior to Interim Payment System implementation, for PPS graphs quarter prior to Prospective Payment System implementation.

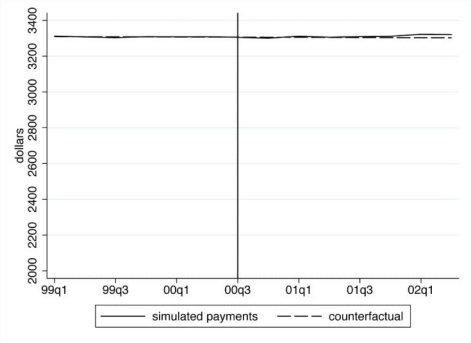
Figure 2.

Simulated home health payments, costs, and admissions after the Home Health Interim Payment System (IPS) and Prospective Payment System (PPS), hospital discharges after stroke

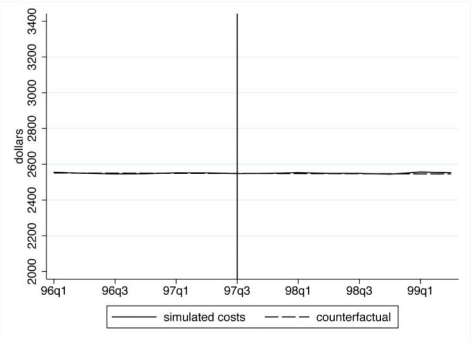
(a) IPS: 99q2 HH payments simulated for each HH cohort



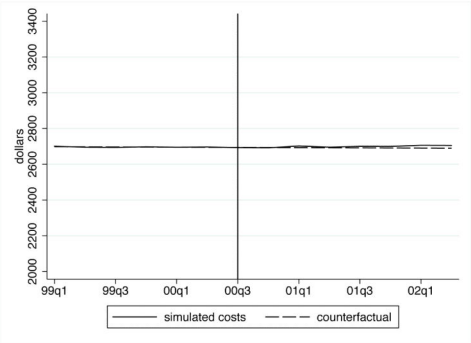
(b) PPS: 02q2 HH payments simulated for each home health cohort



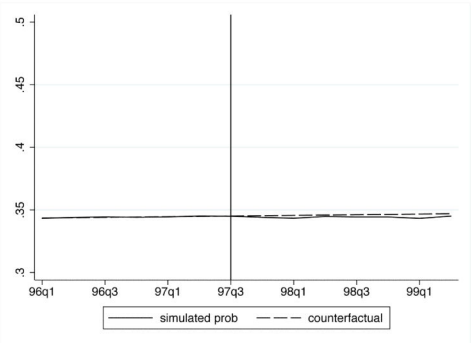
(c) IPS: 99q2 HH costs simulated for each HH cohort



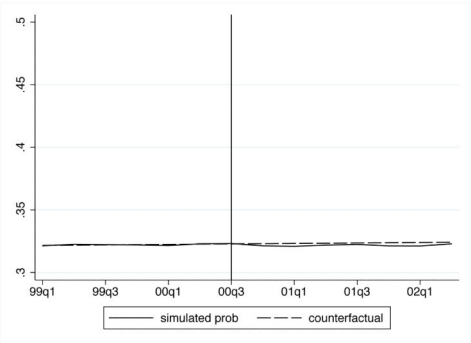
(d) PPS: 02q2 HH costs simulated for each HH cohort



(e) IPS: 99q2 HH admits simulated for each hospital discharge cohort



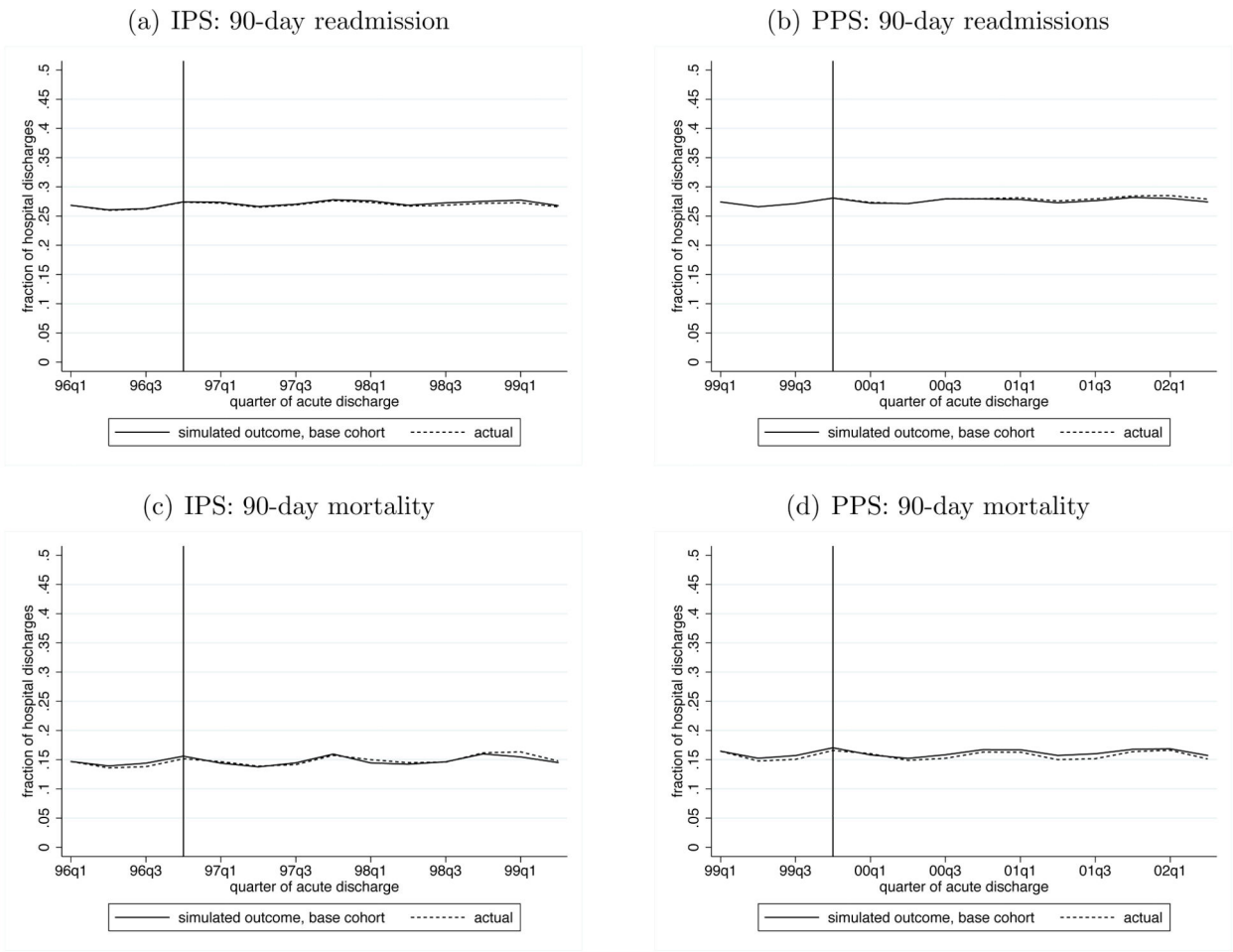
(f) PPS: 02q2 HH admits simulated for each hospital discharge cohort



Note: Measures calculated from 100% Medicare Home Health claims data. Solid line indicates average simulated measures for each quarter. Dashed line indicates pre-IPS or PPS trend. Vertical line in IPS graphs indicates quarter prior to Interim Payment System implementation, for PPS graphs quarter prior to Prospective Payment System implementation.

Figure 3.

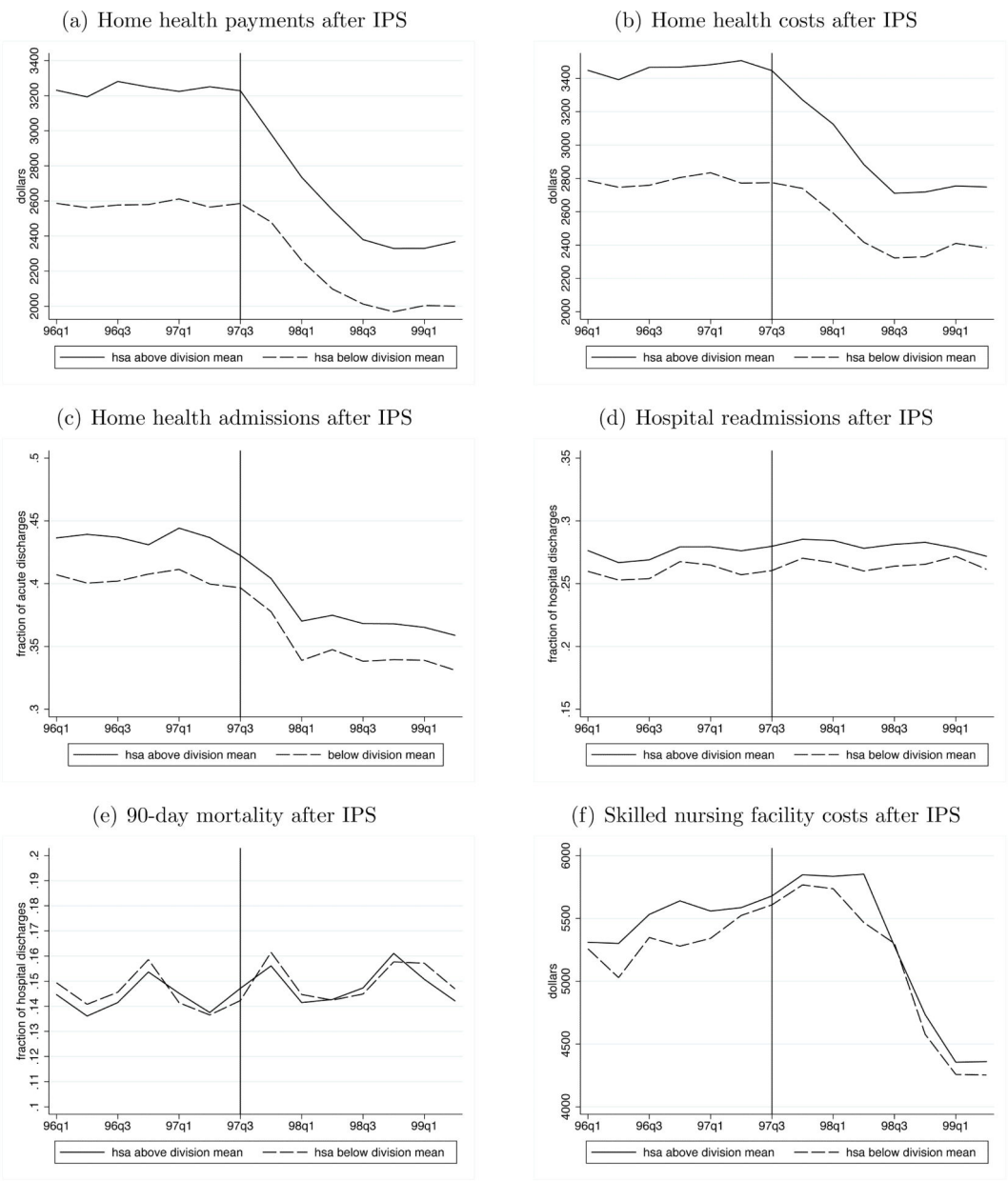
Selection effects for treatment and admissions after the Home Health (HH) Interim Payment System (IPS) and Prospective Payment System (PPS), hospital discharges after stroke



Note: Solid line indicates average simulated measures for each quarter. Patient cohort is hospital discharges after stroke in 96q1 for IPS, hospital discharges after stroke in 99q1 for PPS. Dotted line indicates actual average health outcomes. Vertical line for IPS graphs indicates quarter prior to Home Health IPS implementation, for PPS graphs quarter prior to Home Health PPS implementation.

Figure 4.

Simulated outcomes before and after the Home Health Interim Payment System (IPS) and Prospective Payment System (PPS), hospital discharges after stroke



Note: Solid line indicates simulated outcomes in hospital service areas with average home health visits above census division mean, dashed line indicates simulated outcomes in hospital service areas with average home health visits below census division mean. Index patient cohort is hospital discharges after stroke occurring in 96q1. Vertical line indicates quarter prior to IPS implementation.

Figure 5.

Simulated outcomes for hospital service areas above and below Census Division mean visits in 1996, hospital discharges after stroke

Table 1

Summary statistics for 90-day episodes of care

	(1) Stroke	(2) Hip fracture	(3) Joint replacement
Age	78 (9)	82 (9)	74 (8)
Male	0.41 (0.49)	0.23 (0.42)	0.35 (0.48)
White	0.83 (0.37)	0.93 (0.25)	0.91 (0.28)
Urban	0.71 (0.45)	0.71 (0.45)	0.69 (0.46)
Adjacent	0.16 (0.37)	0.16 (0.36)	0.17 (0.37)
Rural	0.13 (0.34)	0.13 (0.34)	0.14 (0.35)
Any comorbidities	0.72 (0.45)	0.78 (0.41)	0.54 (0.50)
Total comorbidities	1.26 (1.10)	1.49 (1.17)	0.82 (0.95)
Any complications	0.25 (0.43)	0.57 (0.50)	0.41 (0.49)
Total complications	0.30 (0.57)	0.74 (0.77)	0.46 (0.60)
Any home health	0.36 (0.48)	0.45 (0.50)	0.61 (0.49)
Home health payments, conditional on use	2,699 (2,268)	2,487 (1,953)	1,884 (1,499)
Home health costs, conditional on use	2,778 (2,518)	2,421 (2,088)	1,713 (1,477)
Any readmission	0.27 (0.45)	0.24 (0.43)	0.13 (0.33)
Died during episode	0.15 (0.36)	0.12 (0.32)	0.01 (0.09)
N	1,742,251	1,315,803	1,676,087

Notes: Sample includes 90-day episodes following hospital discharges for each primary diagnosis occurring from January 1996 through June 2002. Measures calculated from Medicare claims, denominator files, and cost reports.

Table 2

Treatment and admission policy estimates: effects of Home Health Interim Payment System (IPS) and Prospective Payment System (PPS) on home health payments, costs, and admissions for patients discharged from the hospital after a stroke

	(1) Medicare HH payments		(2) HH provider costs		(3) Home health admissions	
	IPS	PPS	IPS	PPS	IPS	PPS
POST1	−175*** (23)	717*** (25)	−129*** (26)	26 (23)	−0.023*** (0.002)	−0.026*** (0.002)
POST2	−386*** (31)	732*** (28)	−259*** (29)	145*** (25)	−0.060*** (0.003)	−0.013*** (0.003)
POST3	−570*** (42)	699*** (33)	−484*** (39)	75*** (29)	−0.052*** (0.003)	−0.025*** (0.003)
POST4	−694*** (49)	782*** (33)	−619*** (46)	133*** (34)	−0.059*** (0.003)	−0.026*** (0.003)
POST5	−739*** (57)	839*** (34)	−615*** (51)	217*** (35)	−0.057*** (0.003)	−0.013*** (0.004)
POST6	−710*** (63)	787*** (37)	−550*** (58)	286*** (38)	−0.057*** (0.004)	−0.009** (0.004)
POST7	−693*** (66)	723*** (39)	−576*** (61)	252*** (39)	−0.063*** (0.005)	−0.013*** (0.004)
Time trend	0 (4)	38*** (3)	4 (4)	−9** (4)	−0.001*** (0.000)	−0.001** (0.000)
Observations	1,444,990	327,586	444,990	327,586	1,057,868	934,948
R^2	0.327	0.722	0.218	0.051	0.152	0.031
Dep var mean	2,590	2,722	2,872	2,587	0.387	0.331

Notes

* 10 percent. Estimates from regression of simulated payments, costs, or admissions on quarterly indicators POST1-POST7 and quarterly trend. Index cohort is 96q1 patients for IPS, 99q1 patients for PPS. Standard errors calculated from 500 block bootstrap replications.

*** indicates significant at 1 percent level

** 5 percent

Table 3

Selection estimates: effects of Home Health Interim Payment System (IPS) and Prospective Payment System (PPS) on home health payments, costs, and admissions, patients discharged from hospital after stroke

	(1) Medicare HH payments		(2) HH provider costs		(3) Home health admissions	
	IPS	**PPS**	**IPS**	**PPS**	**IPS**	**PPS**
POST1	1 (4)	−5 (4)	1 (4)	−2 (4)	−0.001*** (0.000)	−0.002*** (0.000)
POST2	4 (4)	6 (6)	5 (4)	9 (7)	−0.002*** (0.001)	−0.002*** (0.001)
POST3	2 (3)	1 (7)	2 (4)	3 (7)	−0.001* (0.001)	−0.002** (0.001)
POST4	5 (4)	5 (7)	2 (5)	8 (8)	−0.002*** (0.001)	−0.001 (0.001)
POST5	0 (6)	7 (8)	−2 (6)	9 (9)	−0.002*** (0.001)	−0.003*** (0.001)
POST6	12** (6)	19** (8)	11 (7)	15* (9)	−0.003*** (0.001)	−0.003*** (0.001)
POST7	11* (6)	18** (9)	7 (7)	15 (10)	−0.002** (0.001)	−0.001 (0.001)
Time trend	−1 (1)	0 (1)	0 (1)	−1 (1)	0.000* (0.000)	0.000** (0.000)
Observations	377,585	299,267	377,585	299,267	970,764	901,833
R^2	0.000	0.000	0.000	0.000	0.000	0.000
Dep var mean	2,175	3,310	2,550	2,698	0.344	0.322

Notes

*** indicates significant at 1 percent level

** 5 percent

* 10 percent. Estimates from regression of simulated payments, costs, or admissions on quarterly indicators POST1-POST7 and quarterly trend. Treatment and admission functions for each patient cohort are estimated using 99q2 patients for IPS, and 02q2 patients for PPS. Standard errors calculated from 500 block bootstrap replications.

Table 4

Selection estimates: effects of Home Health Interim Payment System (IPS) and Prospective Payment System (PPS) on home health payments, costs, and admissions, pooled across patients discharged from hospital after stroke, hip fracture, and joint replacement

	(1) Medicare HH payments		(2) HH provider costs		(3) Home health admissions	
	IPS	PPS	IPS	PPS	IPS	PPS
POST1	−5* (3)	−6*** (2)	−7** (3)	−9*** (2)	−0.002*** (0.001)	−0.002*** (0.001)
POST2	−19*** (3)	−13*** (4)	−21*** (3)	−23*** (4)	−0.004*** (0.001)	0.001 (0.001)
POST3	1 (3)	−7* (4)	0 (3)	−17*** (4)	−0.002*** (0.001)	0.003*** (0.001)
POST4	3 (3)	−15*** (4)	1 (4)	−26*** (4)	−0.003*** (0.001)	0.004*** (0.001)
POST5	−4 (4)	−13*** (5)	−7* (4)	−23*** (5)	−0.002* (0.001)	0.003*** (0.001)
POST6	1 (5)	−13** (6)	−3 (5)	−32*** (5)	−0.003*** (0.001)	0.004*** (0.001)
POST7	12** (5)	−4 (6)	9 (6)	−23*** (6)	−0.003** (0.001)	0.006*** (0.001)
Time trend	−3*** (1)	0 (1)	−3*** (1)	0 (0)	0.000* (0.000)	0.001*** (0.000)
Observations	1,251,749	1,148,548	1,251,749	1,148,548	2,547,936	2,538,870
R^2	0.001	0.000	0.001	0.001	0.000	0.001
Dep var mean	1,727	3,101	2,026	2,224	0.456	0.449

Notes

Estimates from regression of simulated payments, costs, or admissions on quarterly indicators POST1-POST7 and quarterly trend. Treatment and admission functions for each patient cohort are estimated using 99q2 patients for IPS, and 02q2 patients for PPS. Standard errors calculated from 500 block bootstrap replications.

*** indicates significant at 1 percent level

** 5 percent

* 10 percent.

Table 5

Spillover estimates: effects of Home Health Interim Payment System (IPS) and Prospective Payment System (PPS) on costs in skilled nursing facilities, inpatient rehabilitation facilities, and long term care hospitals, patients discharged from hospital after stroke

	Home Health IPS			Home Health PPS		
	(1) Skilled nursing	**(2) Inpatient rehab**	**(3) Long term care hosp**	**(4) Skilled nursing**	**(5) Inpatient rehab**	**(6) Long term care hosp**
POST1	105 (64)	20 (41)	13 (27)	204*** (50)	−364*** (47)	−88*** (28)
POST2	50 (92)	19 (56)	2 (29)	446*** (50)	−53 (63)	19 (37)
POST3	−190* (112)	−62 (55)	11 (29)	467*** (55)	−100 (71)	−18 (45)
POST4	−595*** (120)	−4 (66)	−10 (33)	576*** (63)	−83 (80)	34 (39)
POST5	−1,260*** (132)	25 (79)	46 (38)	840*** (73)	−111 (91)	102* (53)
POST6	−1,701*** (155)	103 (90)	55 (42)	923*** (84)	−190* (103)	−67 (58)
POST7	−1,772*** (185)	95 (92)	66 (43)	1,038*** (84)	−148 (109)	−48 (57)
Time trend	70*** (14)	−16** (8)	4 (4)	−66*** (7)	13 (10)	18*** (4)
Observations	1,057,868	1,057,843	1,056,352	934,948	934,948	934,176
R^2	0.036	0.001	0.003	0.008	0.003	0.005
Dep var mean	5,246	3,378	268	4,339	3,532	493

Notes

Estimates from regression of simulated payments, costs, or admissions on quarterly indicators POST1-POST7 and quarterly trend. Index cohort is 96ql patients for IPS, 99ql patients for PPS. Standard errors calculated from 500 block bootstrap replications.

*** indicates significant at 1 percent level

** 5 percent

* 10 percent.

Table 6

Simulated changes in patient outcomes after IPS, by primary cause for hospitalization

	Mortality (90-days post-discharge)			Acute readmissions		
	(1) Stroke	(2) Hip	(3) Joint	(4) Stroke	(5) Hip	(6) Joint
POST-IPS x Q1	0.001 (0.002)	0.003 (0.002)	−0.000 (0.001)	0.000 (0.003)	0.007** (0.003)	0.000 (0.002)
POST-IPS x Q2	0.002 (0.002)	−0.003 (0.002)	0.000 (0.001)	−0.001 (0.003)	0.005 (0.003)	−0.000 (0.002)
POST-IPS x Q3	−0.000 (0.002)	−0.001 (0.002)	−0.000 (0.001)	0.002 (0.003)	−0.004 (0.003)	0.005** (0.002)
POST-IPS x Q4	0.001 (0.002)	−0.005** (0.002)	0.001** (0.001)	−0.002 (0.002)	−0.000 (0.003)	0.000 (0.002)
Q1	−0.010*** (0.002)	−0.014*** (0.002)	0.001 (0.000)	−0.003 (0.002)	−0.004** (0.002)	0.000 (0.001)
Q2	−0.018*** (0.002)	−0.024*** (0.002)	−0.001 (0.000)	−0.011*** (0.002)	−0.014*** (0.002)	0.001 (0.002)
Q3	−0.012*** (0.002)	−0.020*** (0.002)	0.000 (0.000)	−0.009*** (0.002)	−0.007*** (0.002)	−0.000 (0.002)
Time trend	0.000** (0.000)	0.001*** (0.000)	0.000 (0.000)	0.001** (0.000)	0.001*** (0.000)	0.000 (0.000)
Observations	1,057,868	759,794	842,450	1,057,868	759,794	842,450
R^2	0.003	0.009	0.002	0.006	0.013	0.001
Dep var mean	0.147	0.111	0.008	0.271	0.227	0.121

Notes

* 10 percent. Estimates from regression of simulated outcomes on “Post-IPS” interacted with quarter indicators, quarter indicators, and a linear time trend. Index cohort are patients discharged from the hospital in 96q1. Standard errors calculated from 500 block bootstrap replications.

*** indicates significant at 1 percent level

** 5 percent

Table 7

Simulated changes in patient outcomes after PPS, by primary cause for hospitalization

	Mortality (90-days post discharge)			Acute readmissions		
	(1) Stroke	(2) Hip	(3) Joint	(4) Stroke	(5) Hip	(6) Joint
POST-PPS x Q1	0.008*** (0.002)	0.007*** (0.002)	0.000 (0.001)	0.000 (0.003)	0.008*** (0.003)	−0.002 (0.002)
POST-PPS x Q2	0.006*** (0.002)	0.007*** (0.002)	0.001 (0.001)	−0.001 (0.003)	0.005* (0.003)	0.000 (0.002)
POST-PPS x Q3	0.003 (0.002)	0.003 (0.002)	0.001 (0.001)	−0.003 (0.003)	0.002 (0.003)	−0.000 (0.002)
POST-PPS x Q4	−0.002 (0.002)	−0.007*** (0.002)	−0.000 (0.001)	−0.005* (0.003)	−0.003 (0.003)	−0.003* (0.002)
Q1	−0.009*** (0.002)	−0.013*** (0.002)	−0.001*** (0.000)	−0.007*** (0.002)	−0.008*** (0.002)	−0.003 (0.002)
Q2	−0.018*** (0.002)	−0.025*** (0.002)	−0.002*** (0.000)	−0.012*** (0.002)	−0.018*** (0.002)	−0.006*** (0.002)
Q3	−0.013*** (0.002)	−0.021*** (0.002)	−0.001*** (0.000)	−0.006*** (0.002)	−0.014*** (0.002)	−0.001 (0.002)
Time trend	−0.000 (0.000)	0.000 (0.000)	−0.000 (0.000)	0.001*** (0.000)	0.001** (0.000)	0.000** (0.000)
Observations	934,948	706,440	880,096	934,948	706,440	880,096
R^2	0.002	0.006	0.001	0.004	0.011	0.001
Dep var mean	0.161	0.127	0.008	0.276	0.246	0.125

Notes

Estimates from regression of simulated outcomes on “Post-PPS” interacted with quarter indicators, quarter indicators, and a linear time trend. Index cohort are patients discharged from the hospital in 99q1. Standard errors calculated from 500 block bootstrap replications.

*** indicates significant at 1 percent level

** 5 percent

* 10 percent.

Table 8

Difference-in-difference estimates for IPS, hospital service areas above and below division mean number of visits, patients discharged from hospital after a stroke

	Home health utilization			Patient outcomes		Other post-acute costs		
	(1) Payments	(2) Costs	(3) Admissions	(4) Readmission	(5) Mortality	(6) Skilled nursing	(7) Inpatient rehab	(8) LTCH
Above x POST1	−156*** (50)	−147*** (56)	−0.005 (0.005)	−0.001 (0.004)	−0.004 (0.003)	−94 (99)	−10 (68)	35 (44)
Above x POST2	−182*** (34)	−142*** (41)	−0.000 (0.005)	0.002 (0.004)	−0.002 (0.002)	−75 (128)	37 (93)	42 (38)
Above x POST3	−208*** (49)	−213*** (51)	−0.004 (0.004)	0.002 (0.003)	0.002 (0.002)	211 (172)	19 (77)	52 (38)
Above x POST4	−291*** (48)	−291*** (49)	−0.002 (0.004)	0.002 (0.005)	0.004 (0.003)	−196 (153)	56 (105)	63* (33)
Above x POST5	−295*** (51)	−288*** (45)	−0.003 (0.006)	0.002 (0.004)	0.005* (0.003)	−17 (128)	107 (101)	83** (41)
Above x POST6	−330*** (49)	−332*** (44)	−0.006 (0.005)	−0.009*** (0.003)	−0.005** (0.002)	−77 (163)	27 (95)	50 (41)
Above x POST7	−290*** (64)	−312*** (64)	−0.004 (0.005)	−0.005 (0.003)	−0.004 (0.002)	−68 (175)	116 (136)	94* (49)
Observations	409,920	409,920	975,654	975,688	975,688	975,640	975,604	970,869
R^2	0.623	0.550	0.268	0.129	0.051	0.136	0.136	0.050
Dep var mean	2,595	2,875	0.387	0.269	0.147	5,263	3,415	281

Notes

Estimates of regression of simulated payments, costs, and admissions on indicators for POST1 through POST7 interacted with above division mean indicator, hospital service area fixed effects, and quarter fixed effects. Index cohort is 96ql acute discharges. Standard errors calculated from 500 block bootstrap replications. LTCH indicates long term care hospital.

*** indicates significant at 1 percent level

** 5 percent

* 10 percent.

Table 9

Home Health IPS: Changes in probability of home health use and costs as a function of changes in simulated conditional payments

	Stroke	Hip fracture	Joint replacement
1. Predicted change in probability of home health use			
Mean	−0.08	−0.04	−0.07
Δ(simulated payments)	−0.00 (0.00)	−0.00** (0.00)	0.00** (0.00)
Average effect	−0.004	−0.000	−0.025
2. Predicted change in conditional home health costs			
Mean	−527	−522	−232
Δ(simulated payments)	1.06*** (0.03)	1.06*** (0.04)	0.97*** (0.04)
3. Predicted change in unconditional home health costs			
Mean	−421	−322	−268
Δ(simulated payments)	0.46*** (0.05)	0.34*** (0.05)	0.85*** (0.05)
Observations	75,562	54,271	60,175

Notes

* 10 percent. Regressions of changes in simulated admissions and costs between 1st and 14th quarter on changes in simulated payments for index cohort including patients discharged from hospital in 96q1. Standard errors calculated from 500 block bootstrap replications.

*** indicates significant at 1 percent level

** 5 percent

Table 10

Home Health PPS: Changes in probability of home health use and costs as a function of changes in simulated conditional payments

	Stroke	Hip fracture	Joint replacement
1. Predicted change in probability of home health use			
Mean	−0.03	−0.02	−0.03
Δ(simulated payments)	−0.00* (0.00)	−0.00 (0.00)	−0.00** (0.00)
Average effect	−0.022	−0.013	−0.072
2. Predicted change in conditional home health costs			
Mean	114	132	242
Δ(simulated payments)	0.73*** (0.08)	0.49*** (0.08)	0.24*** (0.06)
3. Predicted change in unconditional home health costs			
Mean	−41	101	85
Δ(simulated payments)	0.20*** (0.05)	0.25*** (0.05)	0.08 (0.05)
N	66,782	50,460	62,864

Notes

Regressions of changes in simulated admissions and costs between 1st and 14th quarter on changes in simulated payments for index cohort including patients discharged from hospital in 96q1. Standard errors calculated from 500 block bootstrap replications.

*** indicates significant at 1 percent level

** 5 percent

* 10 percent.