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The Effect of Prospective Payment on Admission and Treatment Policy: Evidence from Inpatient Rehabilitation Facilities
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ABSTRACT

We examine provider responses to the Medicare inpatient rehabilitation facility (IRF) prospective payment system (PPS), which simultaneously reduced marginal reimbursement and increased average reimbursement. IRFs could respond to the PPS by changing the total number of patients admitted, admitting different types of patients, or changing the intensity of care for admitted patients. We use Medicare claims data to separately estimate each type of provider response to the PPS. We also examine changes in patient outcomes and spillover effects on other post acute care providers. We find that costs of care initially fell following the PPS implementation, which we attribute to changes in treatment decisions rather than the types of patients admitted to IRFs. However, the probability of admission to IRFs increased after the PPS due to the expanded admission policies of providers. We find modest spillover effects on skilled nursing home costs and no substantive impact on patient health outcomes.

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1. Introduction

Concerns over the financial solvency of Medicare have focused attention on curtailing health care spending for Medicare beneficiaries. However, these concerns are not new, and the Medicare program has attempted to curtail costs for the past several decades. Perhaps the most important, and certainly the most used, weapon in Medicare's arsenal for lowering costs is a change in the method of Medicare reimbursement to health care providers. The first such major attempt at cost containment was the 1983 implementation of the acute care hospital prospective payment system. The hope was that shifting providers from a cost-based reimbursement to prospectively defined reimbursement would decrease costs. Early evidence certainly suggested that the new payment system reduced both costs and average acute length of stay (Kahn et al. 1990).

However, Medicare continued to reimburse post-acute care (PAC) providers on a cost-basis, leading to an explosion in post-acute care facilities and utilization of post-acute care services in the late 1980s and 1990s (Newhouse 2002). Medicare responded again to this dramatic increase in costs by using its weapon of choice: prospective payment. Between 1997 and 2003, prospective payment systems were implemented for each type of post-acute setting including home health agencies, skilled nursing facilities, inpatient rehabilitation facilities, and long-term care hospitals.

More recently, passage of the health care reform bill has generated interest in a new approach to prospective payment that provides a single "bundled" payment for an episode of care consisting of an acute-care hospitalization and any post-acute care that occurs within a defined period of time. The hope is that this new payment system can tackle the thorny problem of high Medicare costs without diminishing quality of care. In this context, analyzing past experience with prospective payment for post-acute care and understanding its potential effects is important from both an academic and policy perspective.

In this paper, we estimate the effects of the Medicare fee-for-service inpatient rehabilitation prospective payment system (IRF-PPS). Under the IRF-PPS, an IRF receives a payment for providing care to a patient that is based on a "case-mix group", defined by a patient's age, diagnosis, comorbidities, and functional status (Buntin et al. 2006). By decreasing marginal reimbursement for additional services, the IRF-PPS was meant to reduce the use of unnecessary services and lead to a more efficient provision of post-acute care. By determining reimbursement as a function of a facility's case mix and increasing reimbursement for more critical patients, the PPS was meant to improve access to IRF care and discourage selective admission of less severe patients (Buntin et al. 2006, Stineman 2002). Increased average reimbursement for patients treated at IRFs thereby mitigated the incentives to curtail costs inherent in reduced marginal payments (Sood et al. 2008).

We use the experience with IRF-PPS to understand how a change in payment policy such as a bundled payment that simultaneously reduces marginal reimbursement and increases average reimbursement can influence provider behavior. We are not only interested in understanding the effect of this payment change on costs but also in understanding the pathways through which changes might occur. Changes in payments can influence costs in two ways: first, by affecting the "admission policies" or "admission thresholds" of IRFs, that is, the likelihood that a particular patient is admitted to an IRF, and second by affecting the "treatment policies" of IRFs, that is, the intensity of care and type of treatment that a particular patient receives. Moreover, both types of payment changes may have important spillovers for other post-acute care providers because of the substitutability of care across sites (Buntin, et al., 2010). Finally, prospective payment might have deleterious effects on access to or outcomes of post-acute care if facilities respond to prospective payment incentives by either cream skimming or stinting on care (Ellis and McGuire 1996, Rogers et al. 1990).

In this study, we use a consistent empirical framework and a unique and rich data set to estimate these complex and varied effects of the IRF-PPS. Past empirical research on the IRF-PPS and other prospective payment systems, while contributing to our understanding of the impacts of prospective payment, does not simultaneously evaluate all of the potential changes in provider behavior stemming from payment changes (e.g. McCall et al. 2003ab, McKnight 2006, White 2003). In some cases, authors estimate effects conditional on using a site of care and do not take a Medicare-wide perspective in analyzing costs, payments and other outcomes of care (e.g. Sood et al. 2008).

We show that the IRF-PPS led to a substantial increase in payments to IRFs. For example, in the first quarter of 2001, Medicare spent approximately $11,000 per IRF patient with a diagnosis of hip fracture. By the full phase-in of the IRF-PPS in the first quarter of 2003, Medicare spent over 25 percent more on IRF care. Our results suggest that this increase in payments led to an increase in the probability of using IRFs, and that changes in admission probabilities were driven by changes in admission policies of IRFs rather than changes in composition of patients being discharged from acute care hospitals. Despite more generous reimbursement for providers, patients received less intense care once they were admitted to IRFs after the PPS. Again, this reflects changes in treatment policy of IRFs rather than changes in the types of patients admitted to IRFs. Finally, some of the cost savings from reduced intensity of care in IRFs were offset by increased costs at other post-acute care settings. The various changes in patterns of post-acute care, however, did not substantively affect mortality, institutionalization, or acute readmissions.

The rest of the paper proceeds as follows. In section 2, we discuss the IRF-PPS in greater detail. Section 3 describes the conceptual framework, section 4 data, section 5 our empirical strategy, and section 6 presents results. Section 7 concludes.

2. The IRF-PPS

IRFs are inpatient post-acute care sites that provide rehabilitative therapy, either in a hospital-based unit or as part of a freestanding provider. In 2008, over 300,000 Medicare FFS patients received IRF care, with Medicare payments of almost $6 billion dollars (Medpac 2010a). An important factor distinguishing IRFs from other post-acute settings is the intensity of rehabilitation. Medicare requires that patients in IRFs receive 3 hours of therapy per day and mandates that 75 percent of IRFs' patients must be among a set of conditions deemed sufficiently complicated to require such an intense level of therapy.

Prior to the IRF-PPS in January 2002, IRFs were reimbursed based on average costs per discharge, up to a facility-specific limit based on a facility's average costs in its base year of operation (Medpac 2006, Sood et al. 2008). Following the enactment of the IRF-PPS, IRF payment shifted to a prospectively predetermined payment amount per discharge. This payment is a function of the patient's case-mix group (defined by the primary reason for rehabilitation, functional status, age, and comorbidities) and the provider's wage index and other characteristics, and is adjusted for rural status, share of low-income patients, and short-stay and high-cost outliers (Medpac 2010b). Each IRF transitioned to the PPS in its first fiscal year starting after January 1, 2002. Because of variation in fiscal year start dates, the PPS was effectively phased in throughout 2002, with the transition completed by January 2003.

3. Conceptual framework

The conceptual model for the paper is adapted from Hodgkin and McGuire (1994) and Ellis and McGuire (1996). Hodgkin and McGuire (1994) examine the effects of payment change on the intensity of treatment (the "treatment policy"). We model both the decision of the provider to admit patients (the "admission policy") as well as decisions regarding treatment intensity (the "treatment policy").

Consider a provider who has N potential patients eligible for admission into its facility. For each patient, the provider needs to decide the probability of admitting that patient (p_j), as well as the intensity of care, (c_j), provided to the patient once admitted. We assume a general objective function for the provider where the provider derives utility from profits, the probabilities of admitting patients and the intensity of care provided to patients. The probabilities of admitting patients and the intensity of care enter the utility function directly as health care providers might have altruistic concerns about the welfare or health of eligible patients. The provider faces a mixed payment system with an average reimbursement of a_j and a marginal reimbursement of m_j.

First consider the providers' admission problem:

(1.) $\underbrace{Max}_{wrt\, p_j} \; U\big(E(\pi), p_j, c_j\big) \; subject\ to\ E(\pi) = \sum_{j=1}^{N} p_j\big(a_j + (m_j - 1)c_j\big)$

Where a_j is the average reimbursement and m_j is the marginal reimbursement, which is a function of observed accounting costs, p_j is the probability of admitting patient j and c_j is the intensity of treatment or the costs of treating patient j. Thus, $\big(a_j + (m_j - 1)c_j\big)$ is the profit from patient j. The first order condition for admission policy is:

(2.) $[p_j]\colon U_{p_j} = -U_\pi\,\big(a_j + (m_j - 1)c_j\big)$

The above condition shows that providers choose the probability of admission so that the marginal utility of increase in admission probability for a particular patient equals the change in profits from admitting the patient times the marginal utility of profits. Also note that if the patient is profitable, $(a_j + (m_j - 1)c_j) > 0$, the probability of admission is one. In other words, all profitable patients will be admitted, assuming no capacity constraints. If there are such constraints, the provider takes the most profitable patients until the constraint is binding.

We are interested in understanding how provider decisions with regard to admissions change as average, (a_j), and marginal, (m_j), reimbursement change. An increase in either type of reimbursement increases the expected profitability of patients. Assuming $(a_j + (m_j - 1)c_j)$ is negative, this makes the right hand side of (2.) smaller and hence increases the probability of admission and the total volume of patients seen by the provider.

As noted earlier, the IRF-PPS simultaneously increased average reimbursement but decreased marginal reimbursement. Thus, the effects of the IRF-PPS on admission policy are *a priori* ambiguous. Furthermore, the effects of the IRF-PPS on profitability of patients might vary by patient characteristics and depend on how well the case mix adjustment of payments under the IRF-PPS matches the expected costs of treating patients. In general, IRFs have the incentive to increase admission probabilities for patients who became more profitable due to the implementation of the IRF-PPS. We refer to the change in the severity or type of patients seen at IRFs after the implementation of the IRF-PPS as the "selection" effect of the IRF-PPS.

Now we consider the effect of changes in reimbursement on treatment policy or decisions about treatment intensity after a patient is admitted to a facility. The first order condition for treatment policy is:

(3.) $[c_j]: U_{c_j} = U_\pi \left(1 - m_j - E(\pi)\, {}^{\partial N}/_{\partial c}\right)$

The above condition shows that providers choose the treatment policy so that the marginal utility of an increase in treatment intensity for a particular patient equals the change in profits from increasing intensity times the marginal utility of profits. Changes in treatment intensity can affect profits through two channels. First, increases in treatment intensity increase the costs of treating existing patients and so reduce profits. Second, for-profit providers will choose treatment intensity to attract profitable patients subject to a capacity constraint (or a population constraint on profitable patients).

Equation (3) shows that treatment intensity and marginal reimbursement are positively related. An increase in marginal reimbursement reduces the loss in profits from increasing intensity and hence increases the intensity of treatment. An increase in average reimbursement increases the profits of the provider and hence reduces the marginal utility of profits. This in turn reduces the marginal value of loss in profits and hence increases the intensity of treatment. Increases in average reimbursement also increase the profitability of patients, thus making it more lucrative to attract patients by increasing intensity of treatment. Therefore, consistent with the results in Hodgkin and McGuire (1994), our model also predicts that increases in average or marginal reimbursement will increase the intensity of care. Because the IRF-PPS reduced marginal reimbursement and increased average reimbursement, the effects of the IRF-PPS on intensity of treatment are ambiguous.

Finally, the changes in treatment and admission policy of IRFs could also affect patient outcomes and have spillover effects on the behavior of other providers. For example, patients discharged "too early" from IRFs might be at higher risk of suffering adverse health outcomes, being readmitted to acute care hospitals or receiving care from other post-acute care providers.

4. Data and Measures

Our analysis examines post-acute care payments, costs, and health outcomes for patients discharged from acute care hospitals between January 2001 and June 2003 and whose principal diagnosis for the acute admission was stroke, lower extremity joint replacement, or hip fracture. These three conditions are the most prevalent conditions receiving post-acute care, accounting for 25% of all beneficiaries receiving post-acute care. Stroke patients are defined as those with a principal diagnosis in the acute hospital stay of intracerebral hemorrhage (diagnosis code 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 of the femur (820.xx). Lower extremity joint replacement patients[1] were defined as patients with a primary diagnosis for joint replacement, excluding hip fracture patients and patients with reattachment procedures. Hip fracture patients who were treated with partial or total joint replacement are included in the hip fracture group.

The unit of analysis is an episode of care consisting of an acute-care hospitalization for one of the three study conditions, which we call the index hospitalization, plus a fixed period of 90 days following discharge from the acute care hospital. We link a number of data sources to construct the outcome and explanatory variables used in our analysis. In the sections that follow, we describe the construction of the measures used in the analysis.

[1] Referred to as "joint replacement" throughout this paper.

4.1. Data

4.1.1. Medicare Payments and Costs

We use the Medicare claims data linked to data from Medicare cost reports to construct the key Medicare reimbursement and cost measures. The Medicare claims data include 100 percent Medicare standard analytic files (SAF) for home health agency claims from January 2001 to June 2003, 100 percent Medicare standard analytic files (SAF) for skilled nursing facility claims from January 2001 to June 2003, and 100 percent MEDPAR data for acute hospital, IRF, and long term care hospital claims following acute discharges from January 2001 to June 2003. We define IRF and other post-acute reimbursement for each observation as total Medicare payments to IRFs (or other post-acute sites) occurring within a 90-day post-acute episode following an initial acute care discharge.

We calculate the costs per patient incurred by facilities using charges in the claims data and cost-to charge ratios from cost-reports. For acute hospital, hospital-based SNF, IRF, and LTCH costs, we multiply total charges accrued in a given facility by the facility's total calendar year cost-to-charge ratio. For stand-alone SNFs, we multiply routine costs-per-day by the total number of days, plus the ancillary cost-to-charge ratio by ancillary (departmental) charges. For HHAs, we multiply the number of visits by a facility's average calendar year cost per visit.

4.1.2. Health Outcomes

The main health outcome in the study is a binary measure of whether a patient died or was institutionalized in a nursing home at the end of the 90-day period following discharge from the acute-care hospital as opposed to returning to the community. We identify deaths using Medicare denominator files, and whether patients were institutionalized using data from the Minimum Data Set, which reports information from all nursing homes that are certified by Medicare or Medicaid. These nursing homes, including those that provide only custodial care, are required periodically to assess the health and functional status of patients who reside in the facility for longer than 14 days. We also assess readmissions to an acute-care hospital during the 90-day period following discharge from the index hospitalization.[2]

4.1.3. Patient Characteristics

We use information from the index hospitalization and Medicare denominator files to measure patient characteristics. For each patient we collect and control for the list of comorbidities developed by Elixhauser et al. (1998)[3]. We also measure a list of complications that occurred during the index hospitalization[4] including 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; post-operative cardiac abnormalities other than AMI; procedure-related perforation or laceration; venous thrombosis and pulmonary embolism; acute renal failure; miscellaneous complications; delirium; and dementia. We control for hip fracture in stroke and joint replacement patients and for stroke in hip fracture and joint replacement patients. We use information from Medicare enrollment files to describe patient demographics including gender,

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2 Longer post-acute episodes may capture later unrelated readmissions and subsequent costs, whereas shorter episodes may miss related costs, readmissions, and patient outcome. We examine the sensitivity of the results to differing post-acute episode lengths, in analysis not shown, and find similar results.

3 Comorbidities include AIDS, alcoholism, deficiency anemias, rheumatoid arthritis/ collagen vascular diseases, blood loss anemia, congestive heart failure, chronic pulmonary disease, coagulopathy, depression, diabetes without complications, diabetes with chronic complications, drug abuse, hypothyroidism, liver disease, lymphoma, fluid and electrolye 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. We do not include hypertension, as it is ubiquitous in these populations, or cardiac arrythmias.

4 Because we are interested in the costs and health outcomes of post-acute-care, complications that occur during the index hospitalization are important measures of the severity of patients when they are discharged from the acute-care hospital.

age (controlled for separately in 5-year bands), race, whether a patient was covered by Medicaid, and whether the patient lives in a MSA, adjacent to a MSA, or in a rural area.

4.1.4. Acute-care Hospital Characteristics

Our analysis also controls for the characteristics of discharging acute-care hospitals, as these may influence post-acute care. We derive information on the Medicare patient percentage in the previous year from providers' cost reports to CMS. We use the Medicare Provider of Services file, a provider level database maintained by CMS, to determine the ownership status of a particular facility (government, non-profit, or for-profit) and its size. We use information from the Acute Impact file on the wage index, average daily census, number of acute beds, case-mix, teaching status, previous year Medicare patient percentage (of total days), and low-income patient percentage (disproportionate share patient percentage) as additional controls. Finally, we use information from POS files to construct the distance from each patient's zip code to the closest of each type of post-acute care provider as a measure of density of post-acute providers.

Our analysis sample consists of 503,220, 776,249, and 645,213 episodes of care for hip fracture, joint replacement, and stroke respectively. We drop 2.1%, 3.4%, and 2.2% of hip fracture, joint replacement, and stroke episodes respectively due to various missing data. Summary statistics for the analytic sample are presented in Table 1.

5. Empirical Approach

The goal of our empirical analyses is to understand the sources of post-PPS changes in IRF payments and costs across all acute care discharges for each of the three study conditions. To achieve this goal, we develop an empirical strategy that enables us to estimate the effect of the IRF-PPS on per-patient Medicare payments to IRFs, admission policies of IRFs, and per-patient costs incurred by IRFs, holding constant the composition of patients discharged from acute-care hospitals with one of the study conditions as well as the composition of patients receiving care in IRFs. Our strategy also enables us to estimate the changes in outcomes after implementation of the IRF-PPS that are due to changes in the composition of patients discharged from acute-care or receiving care in IRFs. We also investigate the effects of the IRF-PPS on average costs to other post-acute providers, acute readmissions, and mortality and institutionalization. For all analyses, we define the pre-PPS period as acute care discharges occurring during the four calendar quarters from January 2001 through December 2001 and the post-PPS period as the six quarters from 1 January 2002 through 30 June 2003. We estimate separate models for each study condition: hip fracture, lower extremity joint replacement, and stroke.

To summarize, our estimation approach involves empirically describing payment, admission, and treatment policies as a function of patients' observable characteristics, where changes in payments reflect Medicare payment policy and changes in admissions and costs reflect IRF provider behavior. We use these estimates to simulate policies in pre- and post-PPS periods for a constant patient cohort, to isolate the effects of the IRF-PPS on Medicare payments and providers' treatment and admission policies[5]. We then simulate payments, costs, and admissions using a constant set of post-PPS parameters for pre and post-PPS patient cohorts, to isolate effects coming from changes in the composition of patients discharged from acute-care hospitals for admission probabilities and of patients treated in IRFs for payments and costs. We now describe our approach in detail.

[5] This approach is similar in principle to the simulated instrumental variables strategy developed in Currie and Gruber (1996ab).

We characterize the admission policy of IRFs by modeling the probability of using any IRF care for patients discharged from acute care hospitals with one of the study conditions. Specifically, we estimate a probit model with an indicator variable for using any IRF care during a 90-day post-acute episode as the dependent variable. The covariates in the model include patient demographics, comorbidities, complications, acute care provider characteristics, and density of post-acute care providers, as described in the data section. We estimate separate probit models for each quarter. Thus, we allow the admission policy of IRFs or the probability of admissions to IRFs to change flexibly over time, including changes in the intercept that are common across all patients and changes in coefficients on covariates which produce differential changes in admission probabilities depending on patient characteristics or other covariates in the model.

(4.) $p_i^q = \Phi(\alpha^q + \beta^q X_i)$

Next, we use these estimated probit coefficients to estimate the probability of using IRF care in each quarter for a constant cohort of patients discharged from acute care in the first quarter of 2001. These estimates isolate the changes in admission policy of IRFs, as they project the probabilities of admission into IRFs in quarters 2 to 10, with a constant sample of acute discharges from the first quarter of 2001. In order to estimate whether the IRF-PPS caused a change in the admission policies of the IRF we estimate the following interrupted time series model:

(5.) $p_i^q = \alpha + \delta_0 Quarter + \sum_{k=1 \text{ to } 6} \delta_k Post_k$

Where, p_i^q is the probability of IRF admission for patient i if he or she was discharged from acute care in quarter q. $Quarter$ is a linear time trend in quarter of discharge and $Post_k$ is an indicator variable for the k^{th} quarter after implementation of IRF-PPS in January 2002. The coefficients of interest are δ_k which show the average change in probability of admission to IRFs in the k^{th}

quarter due to changes in admission policies of IRFs assuming the linear time trend in the four pre-PPS quarters continued.

We use a similar strategy to estimate the effects of the IRF-PPS on the treatment policies of IRFs. First, we estimate a series of OLS models for patients admitted to IRFs in each quarter that estimate the costs of IRF care as a function of patient demographics, comorbidities, complications, acute care provider characteristics and density of post-acute care providers. Next, we use the estimated cost functions to calculate the costs of IRF care in each quarter for the cohort of patients that were admitted to IRFs in the first quarter of 2001. Finally, to determine whether the IRF-PPS caused a change in the treatment policies of the IRF we estimate the following interrupted time series model:

(6.) $c_i^q = \lambda + \lambda_0 Quarter + \sum_{\mathrm{k=1\ to\ 6}} \lambda_\mathrm{k} Post_\mathrm{k}$

The coefficients λ_1 to λ_6 describe the evolution of treatment policy or cost of care conditional on using an IRF following the implementation of the IRF-PPS.

We also simulate the effects of the IRF-PPS on payments in each quarter for a constant IRF patient cohort and estimate equation (6), in order to show the magnitude of changes in Medicare payments to providers.

We are also interested in estimating the "selection effects" of the IRF-PPS, that is, the extent to which payments and costs of care at IRFs changed due to changes in the types and severity of patients admitted (within each tracer condition), and the extent to which the probability of admission to an IRF changed as a result of changes in the composition of patients discharged from acute-care hospitals. To quantify these effects, we estimate the counterfactual costs for each cohort of patients admitted to IRFs from quarter 1 to quarter 10 using the cost function estimated for IRF patients in the second quarter of 2003, after the IRF-PPS phase-in was complete. Thus, we allow the patient population admitted to IRFs to change over time but keep the treatment policy fixed at 2003 levels. Next, we use the interrupted time series model described above to describe the evolution of selection effects following the implementation of the IRF-PPS. We conduct a similar analysis to estimate the extent to which the probability of admission into IRFs changed due to changes in the composition of patients being discharged from acute care hospitals. To quantify these effects, we estimate the counterfactual probability of IRF admission for each cohort of patients discharged from quarter 1 to quarter 10 using the admission function estimated in 2003 and use the interrupted time series model described above to describe the evolution of admission and selection effects following the implementation of the IRF-PPS.

Finally, we estimate the effects of the IRF-PPS on the costs of care for other post-acute care providers, the probability of readmission to acute care, and the probability of death or institutionalization. The empirical strategy for these outcomes is similar to the strategy used for estimating treatment and admission policy effects. We omit a full description of the strategy in the interest of brevity.

Standard errors in all regression models are clustered at the health referral region (HRR) level (Dartmouth Medical School 1996).

6. Results

We begin by describing our estimates of the IRF-PPS on IRF reimbursement, resource use, and admissions. We then consider the spillover effects of the IRF-PPS on other post-acute settings and its effect on patient outcomes. Finally, we examine heterogeneous effects by differential changes in average payments.

6.1. IRF reimbursement, treatment, and admissions policies

Figure 1 graphically displays predicted IRF payments using coefficient estimates from equations 5 and 6 for each study condition. In each case, the solid line represents the predicted values and the dashed line represents the linear counterfactual trend had the PPS not been implemented (i.e., predictions where the indicator variables POST1-POST6 are set to zero). Accompanying coefficient estimates are displayed in Tables 2a-c for each study condition.

Figure 1a displays simulated Medicare payments in each quarter from 2001 through the second quarter of 2003, for the cohort of hip fracture patients in IRFs discharged from acute care in the first quarter of 2001. Thus, this figure shows changes in Medicare IRF expenditures stemming solely from changes in payment policy. This graph clearly shows a dramatic increase in Medicare payments after PPS implementation beginning in 2002 relative to the payment trend prior to the PPS. The increase in payments flattens after the full phase-in in 2003, nearly $2,400 or more than 20 percent higher than pre-PPS levels. Figures 1b and 1c, show similar payment effects for joint patients (~$2,300 increase) and an even larger effect for stroke patients (>$3,000 increase).

Figures 2 and 3 examine the effects of this dramatic increase in payments on treatment and admission policies of IRFs. Specifically, they display predicted IRF costs and admissions using coefficient estimates from equations 5 and 6 for the three study conditions. As in Figure 1, the solid line represents the predicted values and the dashed line represents the linear counterfactual trend had the PPS not occurred. Accompanying coefficient estimates are displayed in Tables 2a-c and 3a-c for each study condition.

Figure 2a displays projected costs, simulated over the sample period for the 2001 quarter 1 cohort of IRF hip fracture patients. Despite Medicare's increased generosity, resource use for IRF patients initially decreased following the PPS. Corresponding effects for joint and stroke patients are are shown in Figures 2b and 2c. Decreases in resource use are slightly smaller for joint patients and larger for stroke patients .

Figures 3a to 3c show predicted admission probabilities for hip fracture patients discharged from acute care hospitals in the first quarter of 2001, simulated in each later quarter using estimates of equation (4). Because the patient cohort is held constant, changes in admissions probabilities come only from changes in the policies of IRFs. Figure 3a shows a substantial increase of 2.5 percentage points in the probability of IRF admission for hip fracture patients after the PPS. Figures 3b and 3c show corresponding effects for joint and stroke patients. The results for stroke patients are similar to those for hip fracture patients, showing a substantial increase in the probability of admission to IRFs. Probability of IRF admission for joint replacement patients are similar increases following the PPS, but not substantially relative to the pre-existing trend.

Figures 4a and 4b simulate post-PPS (2003 q2) IRF payments for each quarterly cohort of IRF hip fracture patients. Because the simulated payment and cost functions are held constant, the values in these time series only change with shifts in observed patient composition. These results show negligible changes in Medicare payments or provider costs stemming from changes in the composition of IRF patients. Tables 2b and c, columns 2 and 4 show similarly small effects for joint and stroke patients. Finally, Figure 4c simulates post-PPS admission policies (2003 quarter 2) for each acute care discharge cohort. These results also suggest that, relative to pre-PPS trends, there were not substantial changes in patient population discharged from acute care hospitals to IRFs. Estimates in Column (6) in Tables 2b and 2c are qualitatively similar for joint and stroke patients. Overall, we found little evidence to suggest that patient selection based on either the observable characteristics of patients admitted to IRFs or the characteristics of patients discharged from acute care hospitals influenced IRF costs or the probability of IRF use after the implementation of the PPS.

In summary, our results imply that average IRF payments (across all acute discharges) increased after the IRF-PPS both due to more patients from expanded admissions policies and from greater reimbursement per patient. Despite increases in average Medicare payments per IRF patient, changes in treatment policy actually led to reduced resource use initially after the PPS, possibly reflecting decreased marginal reimbursement. The average severity of patients seen in IRFs changed little after the PPS, and played little role in changes in IRF payments or costs.

6.2. Costs in other post-acute settings and patient outcome

Changes in admission and treatment policies in IRFs could in principle lead to changes in costs in other post-acute settings because at least for some patients the various settings are substitutes. For example, the increased admissions in IRFs could have diverted patients from other post-acute settings, while the decreased resource use could increase readmissions. In addition, changes in treatment patterns could affect health outcomes.

Figure 5 shows predicted average costs in other post-acute settings for hip fracture patients – including SNFs, LTCHs, and HHAs – both together and separately. Simulated average costs across all acute discharges are computed by estimating admissions and treatment functions in each quarter. First, we simulate admissions by applying each quarter's admission function to a fixed cohort of patients discharged from acute care hospitals in the first quarter of 2001. Next, we simulate resource use in each quarter by applying each quarter's cost function to a fixed cohort of patients seen in other post-acute settings in the first quarter of 2001. These simulated admissions and resource use measures are multiplied to provide simulated unconditional costs for each quarter. In this calculation, the simulated unconditional costs only change with changes in admissions and treatment policies of other PAC settings, because the patient samples are held constant. In each case, the solid line represents predicted unconditional costs, and the dashed line represents the counterfactual trend without the PPS (i.e. POST1-POST6 in equation 5 set to zero). Results are presented in Figure 5 and Tables 3 and 4.

Figure 5a shows that other post-acute costs initially increased slightly following the IRF-PPS, and Figures 5b-d suggests that this was driven primarily by increased SNF costs. SNF costs subsequently fell, possibly reflecting decreased average payments after the expiration of add-on payments at the end of fiscal year 2002 (Medpac 2007). Similar SNF results are found for joint replacement and stroke patients in Table 4; however, LTCH costs fell substantially for stroke patients after the IRF-PPS, suggesting that some new IRF patients may have previously gone to LTCHs.

Finally, we also simulated the patient outcomes of dead or institutionalized at the end of a 90-day post-acute episode and acute readmission. We followed our previous method of simulating outcomes by first estimating "predicted outcome" functions for each quarter in our sample as a function of observable characteristics, and then using those estimated equations to simulate outcomes for a fixed patient cohort (in this case acute discharges in the first quarter of 2001). Results of this analysis are presented in Table 5. After the IRF-PPS, no appreciable or consistent change was present in the fractions dead/institutionalized or readmitted, suggesting that changes in treatment and admission policies had little effect on patient health.

6.3. Heterogeneous Effects by Average Reimbursement

Finally, we examine how changes in admissions and treatment policies differ across patients with varying changes in average reimbursement. Recall that our empirical framework allows us to estimate heterogeneous treatment and admission policy effects because the treatment and admission functions in each quarter are a function of patient characteristics. Similarly, our empirical framework also allows for heterogeneous changes in Medicare reimbursement following PPS because the payment functions for each quarter are also functions of patient characteristics. Table 6 shows the results from regressing changes in simulated probability, conditional costs, and unconditional costs on changes in simulated payments for the cohort of patients discharged from acute care in the first quarter of 2002. These estimates show that patients with positive predicted changes in payments were less likely to be admitted after the PPS. To the extent that more severe patients received higher average reimbursement (an explicit goal of the PPS), this may reflect a higher perceived financial riskiness of zero marginal reimbursement for such patients. In contrast, a positive and strong relationship exists between changes in average payments and changes in costs (resource use) in panels 2 and 3, signaling that decreases in resource use were smaller for patients with larger increases in Medicare reimbursement to IRFs. For example, the results show that a $1 increase in reimbursement to IRFs is associated with a 52 to 64 cent increase in resource use conditional on admission to IRFs. The estimates for unconditional costs are smaller, of course, because only a fraction of patients use IRFs.

6. Conclusion

In this paper we investigated the impacts of the IRF-PPS. We developed a conceptual framework showing that the PPS may affect facilities' admission criteria, as well as the intensity with which IRFs treat patients. We then employ an empirical strategy that isolates changes in resource use due to changes in treatment policy and patient selection, and decomposes changes in admission probabilities into changes in admission policies and shifts in the composition of patients discharged from acute care hospitals.

We find that average Medicare IRF expenditures across all acute discharges for hip fracture, lower extremity joint replacement, and stroke increased substantially after the IRF-PPS. Increases were driven primarily by increased reimbursement for the types of patients already seen in IRFs and through increased IRF admissions. Despite increased reimbursement, treatment intensity in IRFs decreased after the PPS, implying providers responded to reduced marginal reimbursement by reducing treatment. However, the composition of patients seen in IRFs changed little over this period, reflecting a minimal amount of selection or "cream skimming" by providers after the PPS. Average costs for other post-acute providers increased immediately after the PPS, suggesting that additional rehabilitation occurred elsewhere after the PPS. However, we find little impact of the PPS on patient health outcomes or acute readmissions.

Policymakers continue to wrestle with the joint goals of containing Medicare expenditures while improving quality of care and minimizing acute readmissions. Policy prescriptions range from tweaking post-acute payment updates to proposals for a single "bundled" payment for a combined acute + post-acute episode, possibly including physician cost. Our results show that policies focusing on a single site of care are likely to have some effects on other post-acute settings, supporting more comprehensive payment "bundling" type reforms. However, to the extent that bundling represents a further decrease in marginal reimbursement for providers, our results suggest that this may lead to decreased treatment intensity, even if paired with higher average reimbursement. The decreased intensity that we observed, however, did not lead to changes measures of outcome including death or institutionalization and readmission to the acute care hospital.

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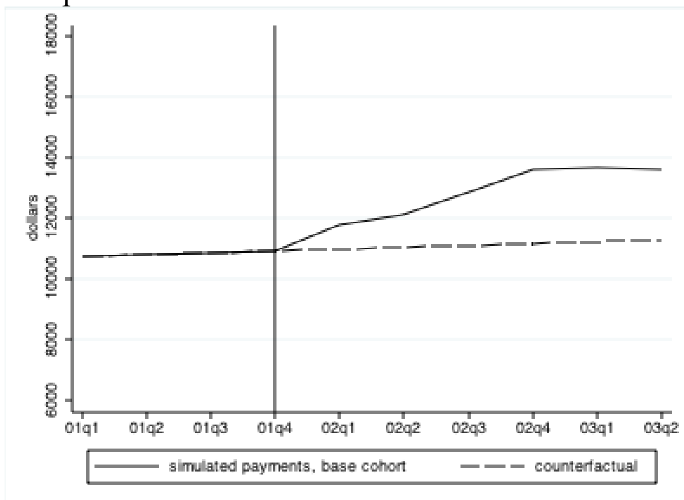
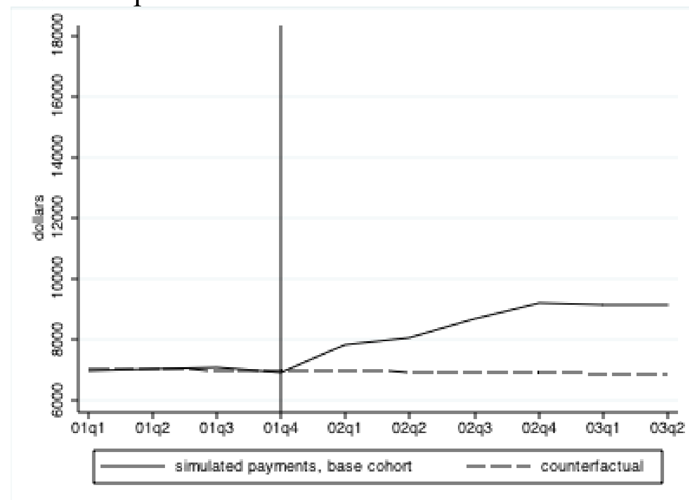
Figure 1. Simulated IRF payments, by study condition

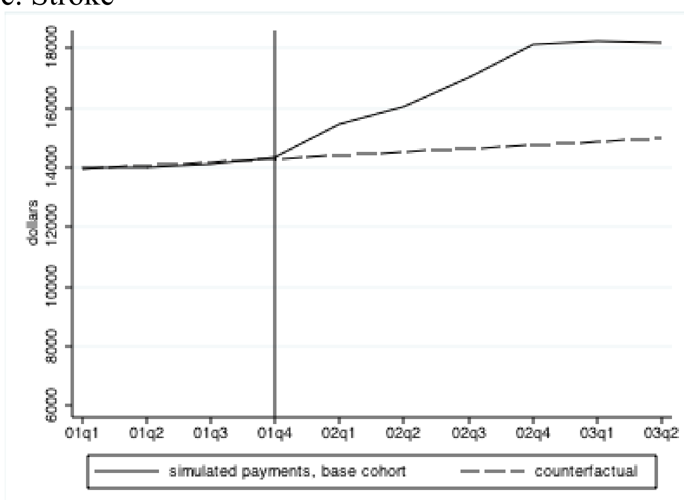
a. Hip fracture



b. Joint replacement



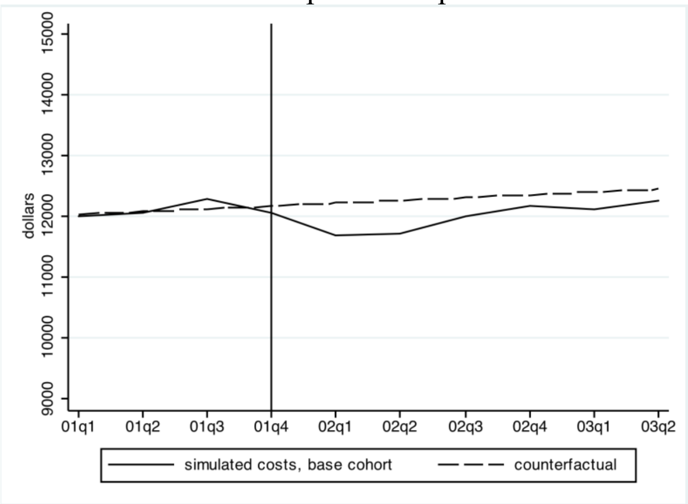
c. Stroke



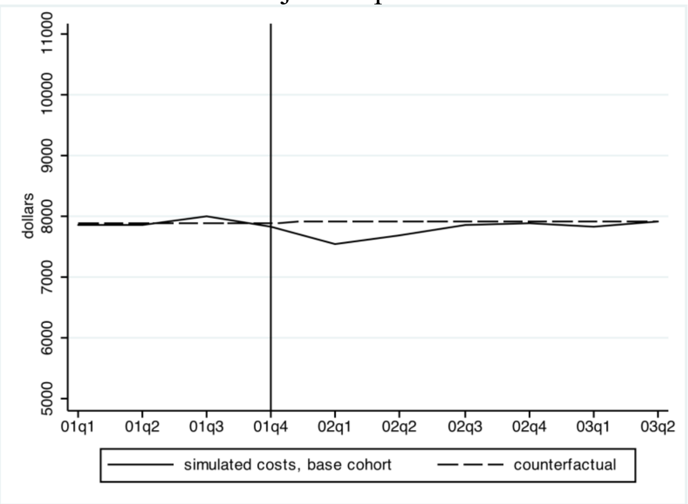
Note: Solid lines show predicted values from regressions, dashed line shows predicted values holding POST1-POST6=0. Vertical line indicates quarter before IRF-PPS.

Figure 2. Treatment policy effects of IRF-PPS, by study condition

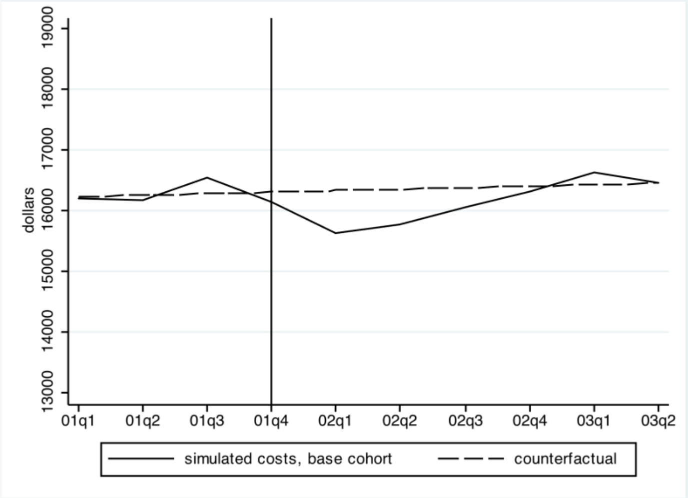
a. Simulated costs for hip fracture patients



b. Simulated costs for joint replacement



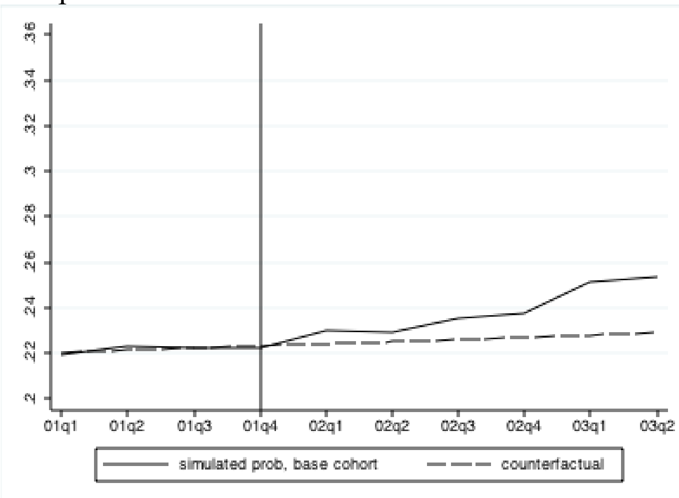
c. Simulated costs for stroke patients



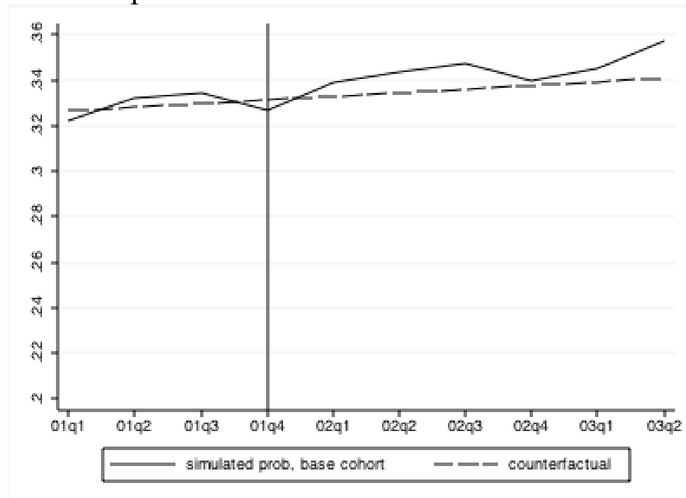
Note: Solid lines show predicted values from regressions, dashed line shows predicted values holding POST1-POST6=0. Vertical line indicates quarter before IRF-PPS.

Figure 3. Admission policy effects of IRF-PPS, by study condition

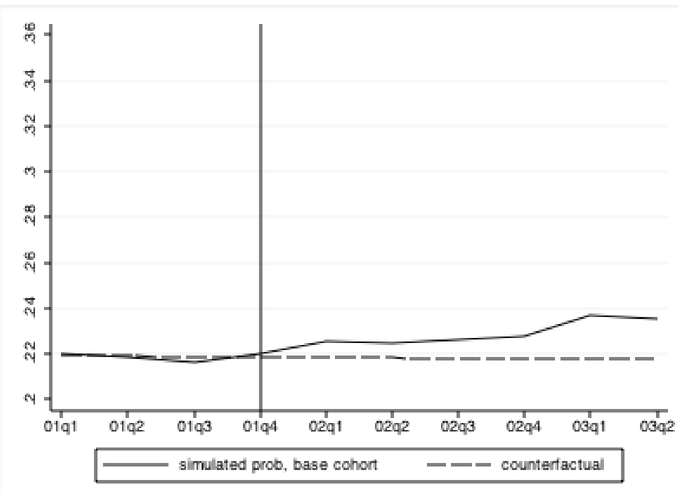
a. Hip fracture IRF admissions



b. Joint replacement IRF admissions



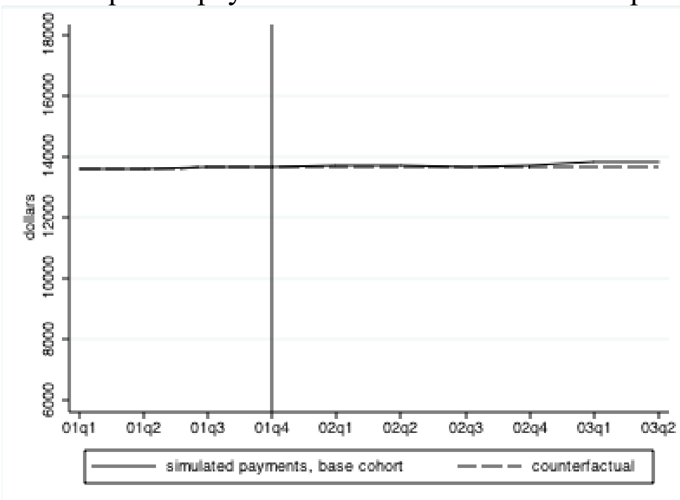
c. Stroke IRF admissions



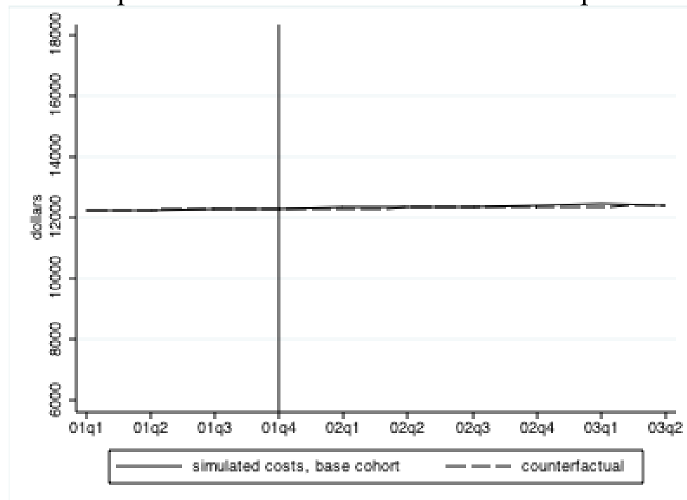
Note: Solid lines show predicted values from regressions, dashed line shows predicted values holding POST1-POST6=0. Vertical line indicates quarter before IRF-PPS.

Figure 4. Selection effects of IRF-PPS, hip fracture patients

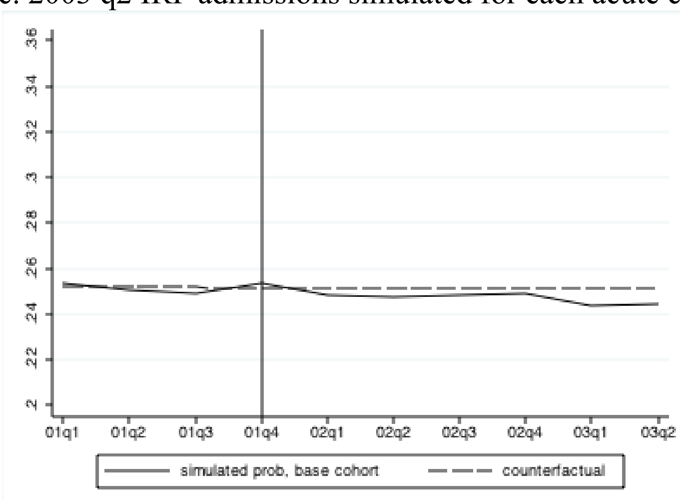
a. 2003 q2 IRF payments simulated for each IRF patient cohort



b. 2003 q2 IRF costs simulated for each IRF patient cohort



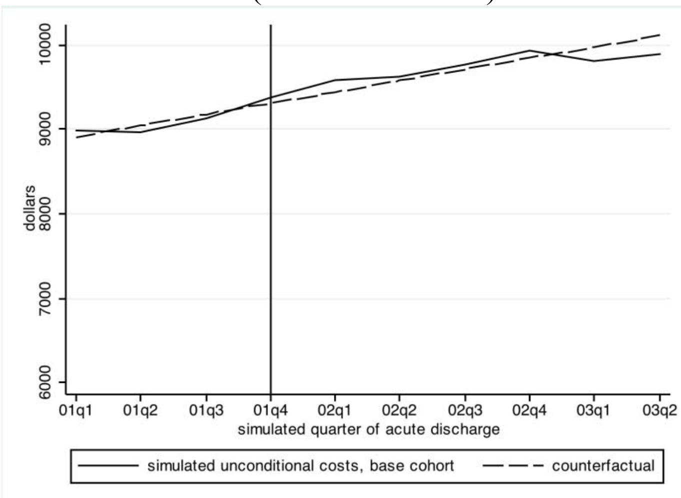
c. 2003 q2 IRF admissions simulated for each acute care patient cohort



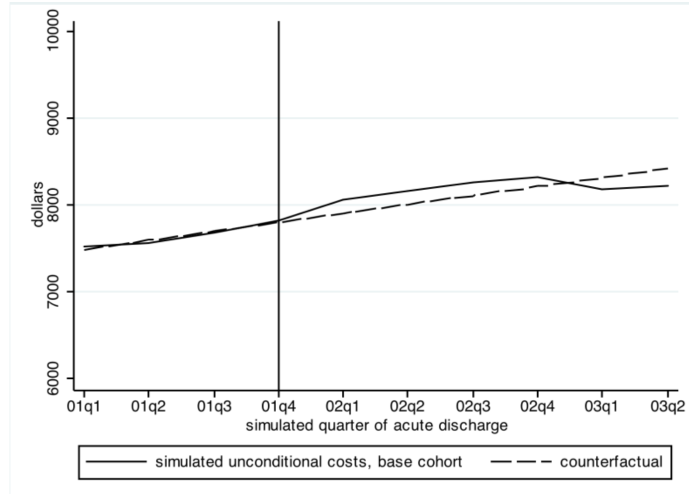
Note: Solid lines show predicted values from regressions, dashed line shows predicted values holding POST1-POST6=0. Vertical line indicates quarter before IRF-PPS.

Figure 5. Spillover Effects of IRF-PPS, Hip Fracture

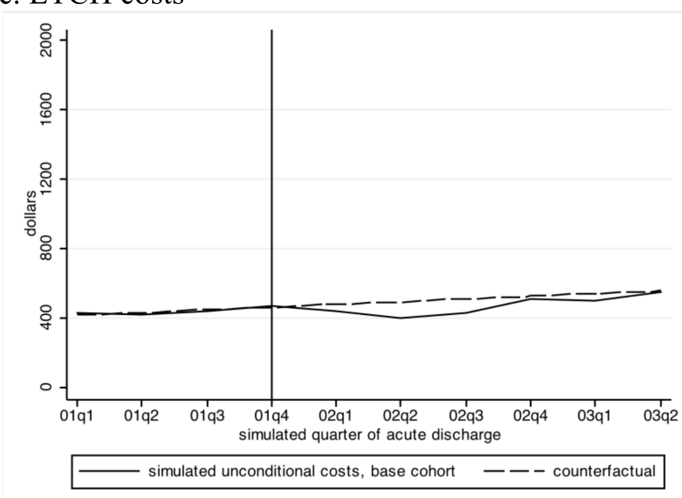
a. Other PAC costs (SNF+LTC+HHA)



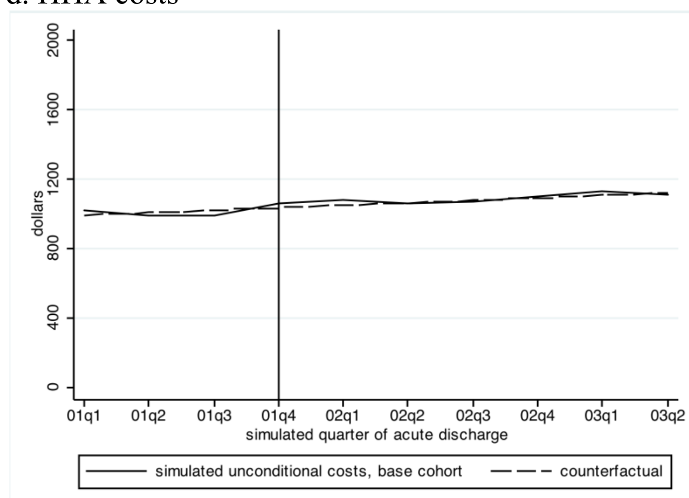
b. SNF costs



c. LTCH costs



d. HHA costs



Note: Solid lines show predicted values from regressions, dashed line shows predicted values holding POST1-POST6=0. Vertical line indicates quarter before IRF-PPS.

Table 1. Summary Statistics

	(1) Hip Fracture, 90 day episode	(2) LEJR, 90 day episode	(3) Stroke, 90 day episode
Age	82.24	73.29	77.75
Male	0.24	0.35	0.41
White	0.93	0.91	0.82
MSA	0.72	0.70	0.72
MSA adjacent	0.15	0.16	0.16
non-MSA	0.13	0.14	0.13
Comorbid conditions(any)	0.82	0.58	0.75
Comorbid conditions(n)	1.64	0.93	1.34
Complications (any)	0.36	0.41	0.26
Complications (n)	0.43	0.46	0.32
Any IRF	0.23	0.34	0.22
IRF conditional payments	12220.88	8199.03	16009.37
Any other post-acute care	0.88	0.71	0.62
Other post-acute conditional payments	10561.29	4745.39	9202.97
Any re-admission	0.26	0.13	0.28
Readmission conditional payments	9618.22	9186.06	9699.28
Dead or institutionalized at 90 days	0.38	0.03	0.33

N	492550	749818	630732

Notes: Data include 90-day episodes following acute discharges occurring from January 2001 through June 2003

Table 2a. Estimated effects of IRF-PPS on IRF payments and costs, hip fracture

	(1) Treatment effect, reimbursement	(2) Selection effect, reimbursement	(3) Treatment effect, resource use	(4) Selection effect, resource use	(5) Admissions, effect, probability of admission	(6) Selection effect, probability of admission
POST1	789.69***	68.67*	-524.73***	57.11	0.005***	-0.003***
	(26.47)	(35.83)	(23.40)	(41.35)	(0.000)	(0.001)
POST2	1,085.87***	49.92	-558.48***	24.49	0.004***	-0.004**
	(35.23)	(40.28)	(18.71)	(49.14)	(0.000)	(0.001)
POST3	1,771.03***	23.17	-293.80***	2.33	0.009***	-0.003*
	(40.24)	(51.16)	(22.86)	(58.83)	(0.001)	(0.002)
POST4	2,446.87***	79.49*	-179.02***	43.15	0.011***	-0.002
	(58.33)	(47.73)	(32.00)	(59.94)	(0.001)	(0.002)
POST5	2,427.92***	199.19***	-285.79***	90.69	0.023***	-0.007***
	(70.23)	(61.27)	(37.33)	(76.51)	(0.001)	(0.003)
POST6	2,340.43***	154.59**	-189.78***	23.46	0.025***	-0.007**
	(78.81)	(66.73)	(44.97)	(83.43)	(0.001)	(0.003)
time trend	60.96***	4.08	45.86***	16.07	0.001***	-0.000
	(5.08)	(8.63)	(5.14)	(10.46)	(0.000)	(0.000)
Observations	111,570	112,249	111,570	112,249	509,430	492,550
R-squared	0.31	0.00	0.01	0.00	0.007	0.000

Notes: *** indicates significant at 1 percent level, ** 5 percent, * 10 percent. Data include 90-day episodes following acute discharges occurring from January 2001 through June 2003. Estimates from regression of payments, costs, or admissions on POST1-POST6 and linear time trend. Standard errors clustered on health referral region.

Table 2b. Estimated effects of IRF-PPS on IRF payments and costs, joint replacement

	(1) Treatment effect, reimbursement	(2) Selection effect, reimbursement	(3) Treatment effect, resource use	(4) Selection effect, resource use	(5) Admissions, effect, probability of admission	(6) Selection effect, probability of admission
POST1	861.03***	-71.79***	-347.68***	-69.78**	0.006***	-0.000
	(18.07)	(24.87)	(18.68)	(29.42)	(0.001)	(0.001)
POST2	1,126.65***	-16.11	-216.08***	-0.93	0.009***	0.003***
	(19.84)	(26.33)	(19.07)	(30.86)	(0.001)	(0.001)
POST3	1,793.86***	-39.08	-50.78**	-26.44	0.011***	0.004***
	(24.81)	(35.02)	(20.53)	(40.45)	(0.001)	(0.001)
POST4	2,306.44***	-54.50	-32.14	-48.24	0.002*	-0.001
	(15.45)	(40.24)	(22.74)	(46.80)	(0.001)	(0.001)
POST5	2,254.05***	-65.60	-85.57**	-94.53*	0.006***	0.007***
	(22.51)	(46.98)	(33.55)	(53.67)	(0.002)	(0.001)
POST6	2,302.01***	-19.68	-8.51	-39.67	0.016***	0.012***
	(29.17)	(47.48)	(33.40)	(53.95)	(0.002)	(0.002)
time trend	-18.87***	23.49***	4.19	28.54***	0.002***	-0.000
	(2.43)	(6.02)	(2.88)	(7.05)	(0.000)	(0.000)
Observations	229,090	256,541	229,090	256,541	711,390	749,818
R-squared	0.26	0.00	0.00	0.00	0.007	0.001

Notes: *** indicates significant at 1 percent level, ** 5 percent, * 10 percent. Data include 90-day episodes following acute discharges occurring from January 2001 through June 2003. Estimates from regression of payments, costs, or admissions on POST1-POST6 and linear time trend. Standard errors clustered on health referral region.

Table 2c. Estimated effects of IRF-PPS on IRF payments and costs, stroke

	(1) Treatment effect, reimbursement	(2) Selection effect, reimbursement	(3) Treatment effect, resource use	(4) Selection effect, resource use	(5) Admissions, effect, probability of admission	(6) Selection effect, probability of admission
POST1	1,065.75***	69.12	-709.22***	54.00	0.007***	-0.003***
	(38.33)	(44.96)	(30.62)	(54.40)	(0.001)	(0.001)
POST2	1,488.68***	103.90*	-596.34***	101.62	0.006***	-0.002***
	(57.96)	(54.50)	(32.99)	(66.25)	(0.000)	(0.001)
POST3	2,387.50***	112.87*	-321.45***	91.51	0.008***	-0.003***
	(83.35)	(60.08)	(29.30)	(72.92)	(0.001)	(0.001)
POST4	3,392.83***	114.82*	-75.16***	90.15	0.010***	-0.003***
	(91.91)	(67.28)	(28.21)	(82.03)	(0.001)	(0.001)
POST5	3,369.78***	147.01*	190.37***	39.64	0.019***	-0.010***
	(102.90)	(80.87)	(65.59)	(99.91)	(0.001)	(0.001)
POST6	3,239.67***	163.04*	2.71	68.42	0.018***	-0.008***
	(111.67)	(86.88)	(59.84)	(110.16)	(0.001)	(0.001)
time trend	113.55***	2.92	24.58***	7.25	-0.000**	0.000
	(4.55)	(10.80)	(4.78)	(13.22)	(0.000)	(0.000)
Observations	148,410	140,700	148,410	140,700	673,930	630,732
R-squared	0.36	0.00	0.01	0.00	0.005	0.001

Notes: *** indicates significant at 1 percent level, ** 5 percent, * 10 percent. Data include 90-day episodes following acute discharges occurring from January 2001 through June 2003. Estimates from regression of payments, costs, or admissions on POST1-POST6 and linear time trend. Standard errors clustered on health referral region.

Table 3. Estimated effects of IRF-PPS on unconditional costs in other PAC settings (SNF+HHA+LTC)

	(1) Hip	(2) Joint	(3) Stroke
POST1	158.56***	121.32***	-48.75***
	(12.25)	(4.18)	(10.32)
POST2	51.66***	152.52***	-152.31***
	(19.88)	(6.92)	(12.06)
POST3	65.02***	136.64***	-169.28***
	(18.93)	(4.32)	(12.70)
POST4	104.52***	125.00***	-118.74***
	(28.26)	(8.74)	(16.19)
POST5	-143.97***	15.46	-312.40***
	(36.47)	(12.83)	(25.23)
POST6	-206.19***	-37.83**	-524.62***
	(39.11)	(15.16)	(22.56)
time trend	129.85***	-2.49*	105.97***
	(3.04)	(1.40)	(2.13)
Observations	509,359	711,390	673,855
R-squared	0.02	0.00	0.00

Notes: *** indicates significant at 1 percent level, ** 5 percent, * 10 percent. Data include 90-day episodes following acute discharges occurring from January 2001 through June 2003. Estimates from regression of costs on POST1-POST6 and linear time trend. Standard errors clustered on health referral region.

Table 4. Simulated changes in other PAC unconditional costs, by site

	HHA			SNF			LTCH		
	(1) Hip	(2) Joint	(3) Stroke	(4) Hip	(5) Joint	(6) Stroke	(7) Hip	(8) Joint	(9) Stroke
POST1	26.05***	70.54***	53.65***	175.14***	66.44***	71.12***	-33.83***	-22.93***	-180.34***
	(1.56)	(1.37)	(1.58)	(12.89)	(5.65)	(5.79)	(10.10)	(3.29)	(8.76)
POST2	-5.08***	52.60***	21.34***	150.83***	120.91***	44.17***	-95.77***	-21.80***	-226.90***
	(1.53)	(1.60)	(2.46)	(16.33)	(7.27)	(10.17)	(11.95)	(3.14)	(10.17)
POST3	-10.62***	42.10***	27.90***	155.77***	111.61***	79.28***	-79.10***	-20.62***	-290.06***
	(2.96)	(1.46)	(2.76)	(19.38)	(6.08)	(11.40)	(13.17)	(3.29)	(10.67)
POST4	2.34	64.17***	40.92***	120.96***	78.65***	75.62***	-21.23*	-21.28***	-248.95***
	(2.80)	(1.49)	(2.27)	(26.05)	(8.82)	(14.19)	(12.83)	(5.73)	(13.11)
POST5	24.38***	102.31***	57.27***	-122.75***	-79.66***	-131.76***	-43.99***	-13.21***	-260.03***
	(2.41)	(1.88)	(2.40)	(34.96)	(13.85)	(18.10)	(13.78)	(4.43)	(14.92)
POST6	-13.20***	54.37***	-4.06	-175.13***	-78.74***	-193.72***	-14.63	-15.47***	-344.60***
	(3.52)	(2.00)	(2.67)	(39.14)	(16.22)	(15.09)	(17.37)	(5.53)	(18.11)
time trend	14.41***	0.72**	2.34***	99.69***	-8.80***	51.00***	15.63***	6.48***	54.94***
	(0.53)	(0.29)	(0.34)	(3.46)	(1.54)	(2.53)	(2.72)	(0.75)	(2.22)
Observations	509,430	711,390	673,930	509,430	711,362	673,930	509,031	710,284	673,362
R-squared	0.01	0.01	0.01	0.02	0.00	0.00	0.00	0.00	0.00

Notes: *** indicates significant at 1 percent level, ** 5 percent, * 10 percent. Data include 90-day episodes following acute discharges occurring from January 2001 through June 2003. Estimates from regression of costs on POST1-POST6 and linear time trend. Standard errors clustered on health referral region.

Table 5. Regression results: patient outcomes

	Dead or institutionalized at end of episode			Acute readmission		
	Hip	Joint	Stroke	Hip	Joint	Stroke
(mean)	0.385	0.029	0.330	0.260	0.131	0.283
POST PPS x Q1	-0.003***	-0.002***	-0.005***	0.001***	-0.002***	-0.001***
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
POST PPS x Q2	0.002***	-0.001***	-0.003***	0.004***	-0.001***	-0.001***
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
POST PPS x Q3	0.002***	-0.001***	0.002***	0.004***	0.000	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
POST PPS x Q4	-0.013***	-0.001***	-0.004***	0.002***	-0.002***	-0.005***
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Q1	0.007***	0.001***	0.005***	0.001	-0.000	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Q2	-0.005***	-0.002***	-0.004***	-0.011***	-0.002***	-0.008***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
Q3	-0.002***	-0.001***	-0.006***	-0.009***	0.001	-0.005***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	509,430	711,390	673,930	509,430	711,390	673,930
R-squared	0.001	0.000	0.000	0.004	0.001	0.002

Notes: *** indicates significant at 1 percent level, ** 5 percent, * 10 percent. Data include 90-day episodes following acute discharges occurring from January 2001 through June 2003. Standard errors clustered on health referral region.

Table 6. Changes in probability of use and costs as a function of changes in simulated conditional payments

	Hip	Joint	Stroke
1. Predicted change in probability of IRF use			
Mean	0.034 (0.030)	0.035 (0.029)	0.015 (0.022)
Δ(simulated payments)	-0.00*** (0.00)	-0.00*** (0.00)	-0.00*** (0.00)
Average effect	***-0.012***	***-0.011***	***-0.004***
2. Predicted change in conditional IRF costs			
Mean	341.72 (1099.27)	135.10 (640.78)	171.70 (1484.70)
Δ(simulated payments)	0.66*** (0.04)	0.63*** (0.02)	0.56 (0.02)***
3. Predicted change in unconditional IRF costs			
Mean	445.88 (442.70)	272.65 (308.20)	291.62 (511.28)
Δ(simulated payments)	0.06*** (0.02)	0.14*** (0.01)	0.12 (0.01)***
N	50943	71139	67393

Notes: *** indicates significant at 1 percent level, ** 5 percent, * 10 percent. Data include 90-day episodes following acute discharges occurring from January 2001 through June 2003. Standard errors clustered on health referral region.