Hospital Responses to Medicare Reimbursement Rate Changes: New Evidence from Medicare's Rural Floor*

Bryan J. Perry†

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Abstract

Hospitals face an environment of declining real per-patient reimbursement from Medicare. Understanding the provider response to changing Medicare prices is critical for balancing the complex incentives of hospitals and patients with the fiscal and social objectives of the public insurance program. In this paper I exploit the Medicare rural floor, a discontinuity in geographic adjustments to Medicare payments to hospitals, in a regression kink design to estimate the impact of Medicare reimbursement rate changes on the level and mix of hospital services provided. I find that hospitals respond to higher Medicare reimbursement by admitting more Medicare patients, but that the average duration of a patient stay declines. I also document a previously unstudied spillover of Medicare reimbursement on the volume of admitted patients with non-Medicare insurance. Contrary to the prediction of existing standard models, both Medicaid and private patient utilization significantly increase in response to Medicare rate hikes. Higher Medicare prices coupled with higher utilization across all patient categories leads to a large increase in hospital revenue. Hospitals deploy the revenue, almost exclusively, in expenses for patient care.

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†MIT Department of Economics, perryb@mit.edu. Website: http://economics.mit.edu/grad/perryb

1 Introduction

Nearly half of all patients treated in US hospitals are insured by Medicare. This population is a stable source of hospital revenue, but hospitals must bear the risk of changes to the centrally-administered reimbursement rates for these patients. Changes to Medicare reimbursement rates are frequent. Indeed, nearly every piece of federal health care legislation adopted over the last two decades changed the expected trajectory of Medicare payments to hospitals. Added to this legislative risk, regulators have and use discretion to routinely adjust payment rules. In order to absorb these changes, hospitals face difficult tradeoffs between continued treatment of Medicare patients, prioritization of other patient populations, and cost reductions that may or may not affect the quality of care they can supply. In this paper I provide new evidence that Medicare reimbursement policy not only affects Medicare patients but also has economically important spillovers to other components of hospital business.

If hospitals were single product, profit-maximizing firms with little to no influence on prices, the analysis of changes in Medicare payment policy would be straightforward: higher prices would lead to greater supply. A greater number of Medicare patients would be treated, and hospital profits would rise. However, hospitals manage many lines of business and face jointness in production between their care of Medicare insured and other patients. Furthermore, many hospitals are non-profits and may have objectives reaching beyond their bottom line. These considerations make the question of how hospitals respond to price changes largely an empirical one. There are many margins on which hospitals might adjust to higher prices: treating more Medicare patients, treating more (or fewer) non-Medicare patients, earning larger profits and paying them to shareholders, raising wages, providing more uncompensated care, or investing in additional capital, to name a few. Taking advantage of exogenous variation in Medicare reimbursement policy, I investigate the margins of hospital responses to changes in Medicare prices.

Though the set of potential hospital responses to Medicare rate changes is wide, clean empirical work to identify the relevant channels is difficult. Medicare reimbursement rates are changed regularly, but usually Congress or regulators are acting in anticipation of or in response to a particular concern. This leads these changes to be correlated with underlying hospital conditions and, therefore, unsuitable for identification of causal effects. However, in one exception, an arcane provision in Medicare reimbursement rules places a floor on the rates received by some hospitals. The average hospital impacted by this floor receives three percent more in Medicare reimbursement (about $120 per average patient). By comparing hospitals that are marginally impacted by the floor to those that just miss its influence, I provide causal evidence of the direct and indirect effects of Medicare reimbursement rate shocks on hospital operations. This exercise reveals that hospitals respond to higher Medicare reimbursement by increasing the volume of patients they treat across

all patient insurance categories (Medicare, Medicaid, and private). This increased volume along with higher Medicare rates generate a significant increase in hospital revenue. Almost all of this revenue is spent on treating patients, with the remainder reversing existing net operating losses. These results are consistent with an upward sloping supply curve for Medicare patients but is at odds with traditional models of hospital patient mix that predict negative utilization spillovers of Medicare rates to private patients (Showalter 1997). Though many have cited these theoretical results, almost no empirical evidence exists to support this hypothesis.[1]

Congress and federal regulators have total discretion in setting both the relative and overall payment levels for the procedures hospitals perform. While the reimbursement formula is set in advance and publicly available, it is riddled with minutia. One such wrinkle occurs in the geographic adjustment of Medicare payments to account for differences in the cost of hospital labor. Since 1998 urban areas have been favored by a floor in this adjustment. Determined by the prevailing wages in the rural parts of each state, this so called "rural floor" arguably has no clear basis in economic theory but generates sizable transfers between hospitals. Importantly for this paper, the rural floor introduces a kink in Medicare reimbursement rates which generates quasi-experimental variation. I exploit this discontinuity in a regression kink (RK) framework (Nielsen et al. 2010).

An increase in the Medicare reimbursement rate leads hospitals to admit more Medicare patients. I estimate that a hospital receiving the mean increase in reimbursement from the rural floor sees 486 additional Medicare patients each year—a 12.6 percent increase. That hospital supply to Medicare patients is upward sloping is not surprising, but the magnitude may be. This increase in supply is partially achieved through decreased average hospital stay length, which does not directly affect Medicare reimbursement levels. The average stay decreases by a third of a day, or seven percent. Decreased stay lengths may be the result of an overall decrease in treatment intensity, perhaps the result of crowding, or of hospitals admitting patients that take marginally less time to treat in response to higher reimbursement. The latter explanation is consistent with hospital triage admission of the highest severity patients. However, there is no measurable effect of increased reimbursement on the Medicare-defined scale of patient diagnostic severity.

The theoretical prediction for the effect of rising reimbursement rates for one patient population on the quantity treated in other patient populations is ambiguous. On the one hand, if hospitals are operating near capacity and expansion is costly, increased utilization of one group may crowd out treatment of others. Hospitals may well actively target the insurer mix of their patients based on the relative generosity of their reimbursement. Indeed, in a recent statement to employees, Mayo Clinic CEO Dr. John Noseworthy

[1] One exception is He and Mellor (2012), who find that more outpatient surgical procedures were performed on privately-insured patients in Florida between 1997 and 2008 in response to Medicare rate cuts.

indicated that the health system would explicitly prioritize privately-insured patients over those covered by Medicare or Medicaid in response to falling federal reimbursement (Olson 2017). On the other hand, an increase in reimbursement rates relaxes the budget constraint for the hospital which may allow them to subsidize low-reimbursement patient populations (e.g. the Medicaid insured). This effect might be especially salient for non-profit hospitals with a charitable mission. Yet another channel could be operating for the privately insured. Medicare reimbursement rates appear to be the starting point for negotiation between many hospitals and private payers (Clemens and Gottlieb 2017). Increases in Medicare reimbursement rates, therefore, could strengthen the relative bargaining position for hospitals, leading to higher overall private rates and thereby the quantity treated.

I estimate that higher Medicare reimbursement not only leads to more Medicare patient utilization, but also leads to more Medicaid and privately-insured admissions. Medicaid admissions rise by 454 (28 percent) and privately insured inpatients increase by 1,234 (20 percent). Though effects are noisily measured, their direction is statistically clear. Consistent with targeting of new, marginally healthier patients, stay length for privately insured patients is 28.4 percent (1.24 days) shorter, on average, at hospitals receiving higher Medicare reimbursement from the rural floor.

The direct effects of Medicare reimbursement changes on Medicare patient treatment and the spillover effects on other patients lead to a large increase in hospital revenue. For the average hospital, that operates at a net loss on patient services, the estimated additional $44.7 million in patient revenue from the rural floor (a 21 percent increase) substantially loosens a usually tight budget constraint. The vast majority of the new revenue is spent on patient expenses ($41.2 million), with the revenue above new costs almost exactly offsetting the usual operating deficit. That the new revenue is not taken as profit is not necessarily evidence of altruistic hospital motives. The extra expenses may in fact be evidence of distribution of rents to employees rather than to hospital owners. That said, both salary and non-salary expense increase in proportion to their share of total operating expenses, countering any narrative of profits being shifted disproportionately to executives.

This paper contributes to a large body of literature concerned with the impacts of Medicare payment policy.[2] While this literature has been inordinately focused on evaluating "cost shifting" between payers (White 2013; Frakt 2011; Wagner 2016), several studies have looked beyond price changes to other outcomes. Cutler (1998) and White and Wu (2014) use "simulated" Medicare price changes to instrument for Medicare prices by holding constant changes they deem to be endogenous to hospital behavior. Cutler (1998) finds that hospitals reduce costs and profits in response to rate cuts. White and Wu (2014) show that not-for-

[2]Duggan (2000) and Baicker and Staiger (2005) also consider hospital responses to Medicare reimbursement policy. Unlike the variation studied in this paper, their work focuses on lump sum transfers to hospitals where the rural floor induces changes in Medicare prices.

profit hospitals offset lower revenue with lower operating expenses, while for-profit hospitals absorb the shock in smaller profits. My findings are generally consistent with these results, though I rely on quite different variation. While these authors use time series variation in a simulated Medicare price, I am able to use cross-sectional variation in the rate actually realized by hospitals. Furthermore, this variation does not suffer from the possibility that hospital expectations of Medicare price mean reversion might moderate the effects of transitory shocks. The rural floor program has been a feature of Medicare reimbursement for two decades, and there is little to suggest that it will go away soon. Employing yet another source of price variation, Dafny (2005) uses changes in relative Medicare rates within diagnoses to show that hospitals adjust their coding behavior, but these price changes are not large enough to allow her to identify effects on financial outcomes.

Reductions in hospital cost raise the question of whether hospitals respond to Medicare price cuts with improved efficiency or reduced quality. Wu and Shen (2014) show that the size of payment cuts to hospitals from the Balanced Budget Act of 1997 was positively correlated with mortality rates, and Lindrooth et al. (2013) show that hospital profitability is related to mortality. Cutler (1995), on the other hand, finds that mortality effects of reimbursement changes are largely explained by relatively small shifts the timing of mortality. This paper does not consider productivity directly, but these findings suggest that cost cutting tends to come with real quality loss. Of course, it is unclear whether the effects of cost cuts in response to lower Medicare reimbursement are symmetric to the effects of cost inflation after rate increases. Finally, when considering patient value of medical care, the correct metric is quality per dollar; improvements in patient outcomes need not be optimal if they come at higher patient costs.

The remainder of the paper proceeds in six parts. Section 2 presents a simple model of hospital patient mix that highlights potential spillover mechanisms between Medicare reimbursement and other patient populations. Section 3 summarizes Medicare reimbursement policy for inpatient care and describes the rural floor. Section 4 discusses the hospital and Medicare data employed and provides summary statistics. The regression kink model is presented and explained in Section 5, and Sections 6 and 7 relate empirical results. Section 8 concludes.

2 A Model of Reimbursement Rate Spillovers

It has long been understood that economic theory predicts a profit-maximizing hospital will raise prices on the privately insured in response to a Medicare rate increase. The effect of the rate increase on quantity, however, is less well studied. Previous work has taken for granted that private patient volume must fall as prices increase (e.g. White 2013; Wagner 2016). In this section I summarize the canonical model of hospital

patient mix choice developed in Morrisey (1994) and Showalter (1997).[3] In order to contextualize the results presented in Section 6, I also highlight the assumption underlying the model prediction that private patient volume will decrease in response to an increase in the Medicare price.

A firm maximizes profits by choosing the number of patients insured by Medicare (Q_{MCR}) and privately (Q_{PRI}). Profits are the sum of revenues from each patient base less the cost of treating all patients.[4] The two patient populations are linked through the cost function; cost is a function of the *total* number of patients treated.

$$\Pi = P_{PRI} \cdot Q_{PRI} + P_{MCR} \cdot Q_{MCR} - C\left(Q_{PRI} + Q_{MCR}\right) \tag{1}$$

The constant Medicare reimbursement rate (or price) is set exogenously by the government regulator. The private price, however, is determined in equilibrium and is a negative function of private patient quantity.

Given the Medicare price and private patient demand, profit-maximizing choices of Medicare and private patients are characterized by

$$C'\left(Q_{PRI} + Q_{MCR}\right) = P_{MCR} \tag{2}$$

$$C'\left(Q_{PRI} + Q_{MCR}\right) = \frac{\partial P}{\partial Q_{PRI}} Q_{PRI} + P\left(Q_{PRI}\right) \tag{3}$$

Equation 2 dictates that an increase in Medicare prices will increase the overall quantity of patients treated, but the mix of those patients between the privately and Medicare insured is determined by the effect of Medicare prices on the marginal private patient revenue including its effect on the private price.

The marginal cost of the last patient treated is equal to the constant Medicare price, which implies that the marginal revenue from the last private patient must also equal the Medicare price.[5] Combining equations 2 and 3 yields the fundamental condition governing the number of private patients treated.

$$P_{MCR} = \frac{\partial P}{\partial Q_{PRI}} Q_{PRI} + P\left(Q_{PRI}\right) \tag{4}$$

The right hand side of equation 4 is the marginal revenue from private patients and is decreasing in quantity. Therefore, when the Medicare price rises, the quantity of private patients treated by the hospital must decrease to maintain optimality. Figure 1 illustrates this prediction graphically. The effective marginal revenue schedule facing the hospital is plotted by the solid, bold line. Marginal revenue decreases as the

[3] Sloan et al. (1978)pioneer an early antecedent of these product mix models in health care.

[4] Glazer and McGuire (2002) model hospitals as choosing the quality of patient treatment that must be common across payers. I abstract from quality considerations here, though I suspect the fundamental insights of this model would carry through in a more general model.

[5] In order to assure a positive number of Medicare patients treated, I assume that the marginal revenue of private patients at the Medicare price is greater than the marginal cost of those patients.

number of private patients increase until it meets the Medicare price. At that intersection, marginal revenue becomes horizontal as Medicare patients are treated at a constant payment rate. Total treated patients (Q_{TOT}) is determined by the intersection of the Medicare price and the marginal cost curve. The number of Medicare patients treated is the difference between Q_{TOT} and Q_{PRI} and is represented by the span below the axis. When the Medicare price increases, the kink in marginal revenue moves up and to the left and the quantity of private patients treated falls. Total quantity increases to match marginal cost to the new, higher Medicare price, thus the number of Medicare patients treated increases due to both the increase in overall production and the improvement in their relative reimbursement value.

The critical assumption in obtaining a clear prediction for the quantity of private patients treated is incorporated in the nature of the cost function. Because the quantity of Medicare patients and privately-insured patients enter additively into a uni-dimensional cost function, the marginal cost of treating either type of patient is equal by construction. The first order conditions then imply equality of marginal revenues between the patient types. In practice there may be reason to believe that different types of patients draw from different pools of hospital resources and that costs, therefore, are not solely determined by the total number of patients treated. I explore these considerations more fully in Section 6 and the appendix.

3 The Medicare Rural Floor for Inpatient Reimbursement

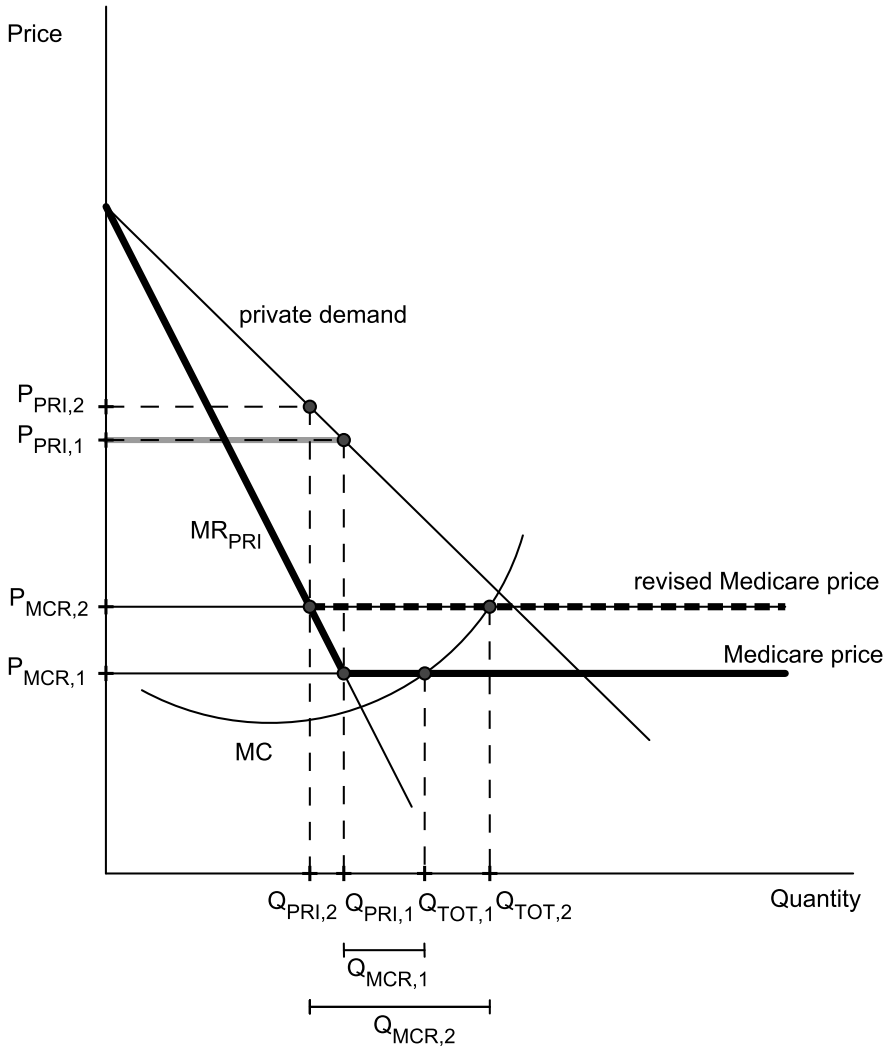
3.1 Medicare Inpatient Reimbursement

For a majority of patients covered by Medicare, hospitals are paid for inpatient services on a per-discharge basis under the hospital inpatient prospective payment system (IPPS).[6] Reimbursement for each patient is primarily determined by the patient's diagnostic condition and the hospital's geographic location.[7] This reimbursement is split into two parts meant to cover the operating and capital costs of treatment. The IPPS sets a base rate each year for each part and these are adjusted for the severity of the patient's condition (or their MS-DRG weight). Geographic adjustments to the two rates are intended to address the regional differences in capital and labor costs.

[6]This paper will not consider inpatients covered by Medicare Advantage, though they represent an ever increasing share of the Medicare beneficiary population (see Curto et al. 2017). Nor will it consider payments for Medicare hospital outpatient or physician-based care (see Newhouse 2002 for a broader discussion of Medicare reimbursement).

[7]In practice, the IPPS adjusts these reimbursement rates for a host of factors beyond diagnostic severity and geographic location. These adjustments span considerations that include graduate program residents (DGME and IME; see Rich et al. 2002), disproportionately indigent patient populations (DSH; see Duggan 2000 and Baicker and Staiger 2005), extraordinary costs, use of high-cost technologies in treatment, quality performance (readmissions, VBP, and HAC; see Gupta 2016 and Norton et al. 2016), and electronic medical record adoption (EHR; see Adler-Milstein et al. 2013). I abstract from those adjustments in this discussion, but they are included in the revenue results presented later. In addition to the program-specific references above, see Centers for Medicare & Medicaid Services (2016) for an overview of these programs. The online appendices of White (2013) and Krinsky et al. (2016) detail the IPPS reimbursement formulas in detail.

Figure 1: Maximizing Margins Model



Notes: This figure plots the predictions of the maximizing margins model (Morrisey 1994) for Medicare and private utilization in response to an increased Medicare price. Initially, the Medicare price is set at $P_{MCR,1}$. The hospital treats $Q_{TOT,1}$ patients at the level where this price is equal to marginal cost. The mix between Medicare and private patients is determined by the intersection of the Medicare price with marginal revenue from private patients. When the Medicare price increases to $P_{MCR,2}$, the total quantity increases to $Q_{TOT,2}$ in line with the marginal cost curve. The intersection of the new Medicare price and private marginal revenue shifts such that the quantity of private patients treated falls from $Q_{PRI,1}$ to $Q_{PRI,2}$. The quantity of Medicare patients treated (the distance between Q_{PRI} and Q_{TOT} in each period) increases both in level and as a share of the total.

Equations 5 and 6 summarize the approximate reimbursement policy for a single patient under the IPPS:

$$Reimbursement^{op} \approx Base^{op} \times DRG \times [LRP * WI + (1 - LRP)] \tag{5}$$

$$Reimbursement^{cap} \approx Base^{cap} \times DRG \times WI^{\alpha} \tag{6}$$

where $Base^{op}$ and $Base^{cap}$ are the base operating and capital reimbursement rates, DRG is the patient-specific diagnostic severity adjustment factor, and LRP is the labor-related portion of operating reimbursement. The key metric at the heart of the geographic adjustments is the Medicare wage index (WI). Calculated at the core based statistical area (CBSA) level, the wage index captures regional differences in the labor supplied by and wages of non-physician hospital employees (e.g. management, contract labor, housekeeping, etc.). CBSAs are geographic areas with an urban center of at least 10,000 people plus adjacent, socioeconomically tied counties, so all but a few states have areas that are not included in any CBSA. The Medicare wage index is also calculated for hospitals in these "rural" areas, grouping all hospitals within a state not located in any CBSA together. A fraction of the operating reimbursement (the "labor-related portion", LRP, or "labor share")[8] and all of the capital reimbursement are adjusted by the wage index.[9] The wage index is raised to a fractional power (α) in order to reduce dispersion before it adjusts capital reimbursement.[10]

The only element of the reimbursement rates that vary at the patient level is the DRG weight. Using the average DRG weight across Medicare patients treated within a hospital (the "case mix index" or CMI), total revenue from Medicare patients can be described with equation 7, where N is the number of Medicare patient discharges.

$$Medicare\,Revenue \approx CMI \times N \times \{Base^{op} \cdot [LRP * WI + (1 - LRP)] + Base^{cap} \cdot WI^{\alpha}\} \tag{7}$$

3.2 The Rural Floor

As part of the Balanced Budget Act of 1997, Congress required that no urban hospital be assigned a wage index less than a rural (i.e. not located within a CBSA) hospital in its own state.[11] This rural floor (which in fact sets a floor for urban hospitals) is budget neutral in nature—if hospitals in one area have their wage index increased due to the floor, the wage index is proportionally decreased for other hospitals, so expected

[8] The labor share is 62 percent in areas with a wage index at or below the national average. In areas above the national average, the labor share changes periodically; it ranged between 68.8 and 71.1 percent between 2005 and 2017.

[9] A positive cost-of-living adjustment to the non-labor related portion of the operating reimbursement is applied for hospitals in Alaska and Hawaii.

[10] This alternate index is sometimes referred to as the geographic adjustment factor (GAF).

[11] Some states have no hospitals in rural areas. For these states (New Jersey, Rhode Island, and Massachusetts before 2012), a rural floor is imputed through a function of the lowest and highest wage indexes in the state.

CMS outlays remain unchanged. Originally budget neutrality was calculated state by state. High wages in rural California had no impact on hospitals in Vermont. However, this was changed to national neutrality as part of the Affordable Care Act in 2010.[12]

The initial wage index is determined at the CBSA level annually, but some CBSA boundaries include areas from more than one state.[13] As the rural floor is set within each state, the effective unit of variation in the wage index is the CBSA by state by year level. The formula for the wage index in CBSA c, state s, and year t is

$$WI_{cst} = \gamma_{st} \cdot \max\left\{WI_{cst}^{unadj},\, RF_{st}\right\}$$

where WI^{unadj} is the wage index in the absence of the rural floor, RF is the wage index for rural hospitals within each state in each year, and $\gamma_{st} \in (0, 1)$ is the budget neutrality factor (restricted to be constant across states after the passage of the ACA).[14] This formula can be rewritten as a function of a normalized wage index: $NWI_{cst} = WI_{cst}^{unadj} - RF_{st}$.

$$WI_{cst} = \begin{cases} \gamma_{st} \cdot WI_{cst}^{unadj} & \text{if } NWI_{cst} \geq 0 \\ \gamma_{st} \cdot RF_{st} & \text{if } NWI_{cst} < 0 \end{cases}$$

To visualize the impact of the rural floor policy on the wage index, Figure 2 plots the theoretical and empirical (for FY 2012) relationships between the normalized wage index and the impact of the rural floor on the final wage index.[15] The solid, red lines plot the impact the rural floor would have on the wage index if there were no budget neutrality adjustment ($\gamma_{st} = 1$). While areas with a normalized wage index greater than zero would feel no impact of the rural floor policy, the wage index increases one-for-one as the normalized wage index falls below zero. To estimate the average budget neutrality factor (γ_{st}), I note that the wage index for areas above the rural floor can be written as $WI_{cst} = \gamma_{st} \cdot NWI_{cst} + \gamma_{st} RF_{st}$. A regression of the final wage index on state-by-year fixed effects and the normalized wage index for areas above the floor reveals an average budget neutrality adjustment of -1.8% (t = -9.8), roughly in line with published CMS estimates.[16] Outliers in Figure 2 are due to measurement error in the unadjusted wage index caused by inconsistency in the timing and methodology of CMS reporting.

The rural floor is not the only adjustment that affects the raw wage index. Current law provides several

[12] In *Cape Cod Hospital v. Sebelius* (2009) it came to light that CMS made errors in applying budget neutrality. Not only were errors in calculation made but also the budget neutrality adjustment was made by adjusting the base rate instead of the wage indexes. CMS has since settled with many hospitals in the matter.

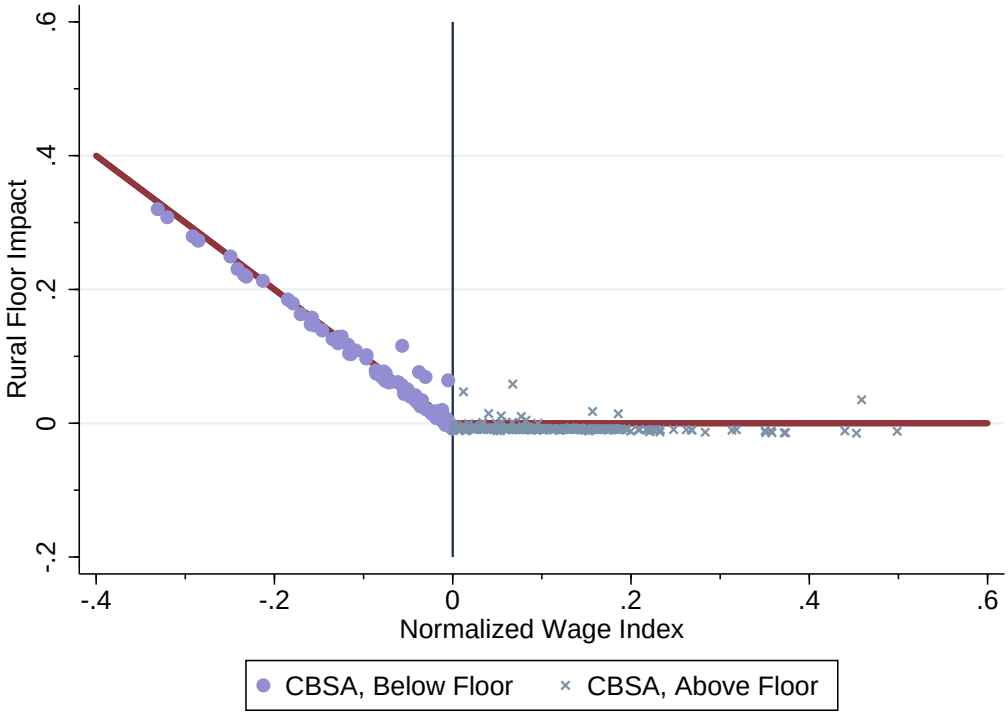
[13] To preserve simplicity in exposition, hereafter references to CBSAs include the non-CBSA area within each state taken together as if it were its own CBSA.

[14] The appendix contains table with all state adjustment factors for 2010.

[15] The empirical relationship is similar for other years in my data.

[16] For example, in 2010 the state-weighted average adjustment was -2.2%.

Figure 2: Impact of the Rural Floor on the Wage Index



Notes: This figure plots the impact of the rural floor on CBSA-states in theory and practice for FY 2012. The data points represent the combination of a CBSA-state's unadjusted wage index normalized by the rural floor (horizontal axis) and the impact of the floor on its ultimate wage index (vertical axis). CBSAs falling below the rural floor are plotted in purple dots, and CBSAs above the rural floor are plotted in blue X's. The solid lines represent the theoretical impact of the rural floor on the wage index absent the budget neutrality adjustment. When the normalized wage is negative (the unadjusted wage index is below the rural floor), the wage index is increased one-for-one by the rural floor with the normalized wage index. When the normalized wage index is positive, the rural floor has nearly zero impact.

Table 1: Medicare Wage Index Reclassifications by Type

	# Hospitals	% Hospitals
Rural Floor	336	9.8
Frontier	26	0.7
MGCRB	655	19.1
Out-Migration	556	16.2
Section 401	40	1.2
Section 508	89	2.6
Lugar	39	1.1
Total	1,287	37.6

Notes: This table presents the number and fraction of the 3,423 hospitals paid under IPPS in FY 2012 eligible for a wage index adjustment or exception under several statutory rules. The categories are not mutually exclusive. Data from American Hospital Association (2011).

avenues for reclassification, some discretionary and some, like the rural floor, automatic. Table 1 presents the number and fraction of hospitals eligible for a wage index under each program in FY 2012. The categories of eligibility are not mutually exclusive, but the totals in the final row eliminate any duplication. Nearly ten percent of all hospitals qualify for a rural floor adjustment to their wage index. The other automatic wage index adjustment is for "frontier states." Incorporated in 2010, states where population density in at least half of counties is below six people per square mile benefit from a wage index floor set at the national wage index average.[17] The form of this exception is identical to the rural floor, with the floor level set by the within state rural area replaced by the national average.[18] These frontier state adjustments are included in the analysis and discussion of the rural floor through the remainder of the paper.

A significant fraction of hospitals receive exceptions to their initial wage index through voluntary application under one of several statutes. The most often used of these are out-migration and the Medicare Geographic Classification Review Board (MGCRB). The out-migration program allows all hospitals within a county to apply together to have a higher wage index from a neighboring county blended with their own by providing evidence on the commuting patterns of hospital professionals between the two areas. The MGCRB reviews applications from individual hospitals that wish to be grouped in an adjacent CBSA with similar wage costs to their own. While CMS has discretion in approving applications under these voluntary programs, in practice they appear to be quite lenient, and the final wage index is significantly impacted by both automatic and discretionary adjustments.

Because the wage index rural floor creates winners and losers, the policy has been widely criticized. In particular, the change from within-state to national budget neutrality motivated a coalition of twenty state hospital associations to petition for a change (Bascuas 2013). While adjusting hospital reimbursement levels to reflect the differential cost of care provision is economically justifiable, the structure of the rural

[17] By this definition Montana, North Dakota, South Dakota, Wyoming, and, until 2013, Nevada qualified as frontier states.
[18] Unlike the rural floor, though, the frontier state adjustment is not required to be budget neutral.

floor policy is not grounded in economic theory or empirically motivated. The Medicare Payment Advisory Committee (MedPAC) itself has said, "We are not aware of any empirical support for this policy, which implicitly assumes that rural areas always have wages that are equal to or below wages in urban areas" (Medicare Payment Advisory Commission 2013). An economic rationale for the rural floor must assume that the prevailing local wages in a rural area of a state could under no condition be higher than the local wages in an urban area. There are two obvious criticisms to such a claim. First, scarcity of skilled medical labor in rural areas relative to urban areas would, all else equal, imply a higher market-clearing wage in the former. Second, the "rural" area of a state is defined as the complement of CBSA boundaries determined by the OMB. It is not immediately clear that these boundaries closely correspond to true hospital market boundaries on the demand or supply side, nor are "rural" hospitals always rural. In Massachusetts, the only rural hospital in the state is in Nantucket, a popular seasonal vacation destination for wealthy travelers. This hospital, with its extremely high wages, sets a floor for all other hospitals in the state.[19]

4 Data and Summary Statistics

In order to analyze the effect of the Medicare rural floor policy on hospital behavior and financial standing, I collect data on the Medicare wage index and acute, short-term hospitals. These data are drawn from public hospital records and regular reports issued by CMS.

4.1 Medicare Wage Index

I use variation in the normalized wage index to identify the effects of changes in the Medicare reimbursement rate. To construct this normalized index, I collect the unadjusted wage index values (the wage index before any rural floor or other reclassification adjustments are imposed) for every CBSA-state and the rural-area wage index for each state between 2005 and 2015.[20] CMS issues several reports each year pertaining to the wage index. Preliminary versions of the wage index are issued up to thirteen months ahead of the fiscal year, so hospitals can submit corrected wage information or apply for reclassification. I take reported wage index in the last version of these preliminary releases (usually issued July preceding the fiscal year) to be

[19] The history of Nantucket Cottage Hospital with the rural floor illustrates the sometimes perverse incentives of the policy. In 2007 Partners HealthCare System, a large Massachusetts hospital chain, acquired Nantucket Hospital and converted its Medicare payment status to allow it to qualify for rural status. When in 2010, then Senator from Massachusetts, John Kerry amended the Affordable Care Act to change the rural floor calculation from budget neutral in every state to budget neutral nationally, Massachusetts hospitals received more than $200 million more each year in reimbursements, at the expense of other states (Kowalczyk 2011; Jan 2013). The rural floor saga with Nantucket continued in 2016 when hospital administrators inadvertently reported wages that were too low, decreasing the rural floor adjustment for other Massachusetts hospitals and reportedly forcing layoffs of more than a thousand hospital employees (Kowalczyk 2016).

[20] While the rural floor policy began in FY 1997, digital records of the wage index are only readily available for 2005 onward, motivating this range of sample years.

the unadjusted wage index. The rural floor is taken to be set by the unadjusted wage index for the rural parts of each state in each year.

The final wage index used for hospital reimbursement is not equal to the maximum of unadjusted wage index and this rural floor for two reasons. First, this definition does not incorporate the balanced budget adjustment for the rural floor. As this adjustment is uniform (at least within state) across hospitals, the maximum of the unadjusted wage index and the rural floor would be perfectly correlated with the true final wage index in the absence of hospital reclassifications. These reclassifications pose the second measurement challenge. Adjustments are made to both the baseline urban wage index and the rural wage index (and thus to the floor) when counties and hospitals successfully reclassify into other geographic areas. This change in the wage indexes is endogenous to hospital behavior, so I use the version that does not incorporate it. Thus the unadjusted wage index is a noisy, but strongly correlated measure of the true wage index values, which motivates the use of a "fuzzy" regression discontinuity design in section 5.

The difference between the unadjusted wage index and the unadjusted rural floor, or normalized wage index, is the primary source of Medicare reimbursement variation leveraged in this paper. By definition, there is no variation in this measure in rural areas (where the wage index and the floor are always the same), so I necessarily restrict my attention to hospitals within urban CBSA boundaries.[21]

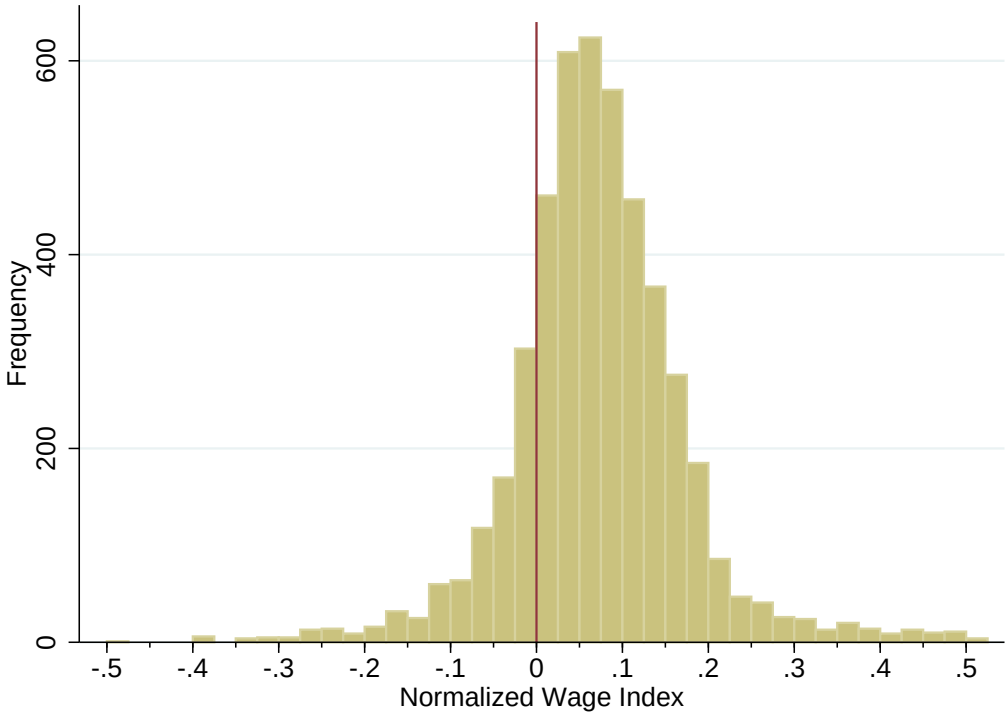
Some CBSAs have wage indexes that are as much as fifty percentage points away from the rural floor in their state, but most areas are significantly closer. Figure 3 plots a histogram CBSA by state by year observations of the NWI. The rural floor binds in areas to the left of the vertical line at zero, while areas to the right are only affected indirectly by the rural floor through budget neutrality. Almost 18 percent of areas fall below the rural floor, though this changes somewhat year to year (minimum of 13.4 percent in 2005 and maximum of 23.7 percent in 2015). As reported in Table 2, the distribution of wage index values is shifted to the right when tabulated at the hospital-year level because CBSAs falling above the rural floor have more facilities, on average, than those below.

Figure 4 shows the intensity of the NWI across the geography of the United States for FY 2012. The white areas represent the rural parts of each state, while the shaded areas are the urban CBSAs.[22] Some states, like California, have a wide disparity in the NWI ranging from areas with a wage index well below the rural floor (e.g. Madera and El Centro) to areas with local wages far exceeding the rural floor (e.g. San Jose-Sunnyvale-Santa Clara and Redding). Other states, like Michigan, have little variation in NWI. While more populous areas tend to have a higher NWI than the sparser parts of their own state, the normalization by the rural floor seems to be fairly idiosyncratic. There is no clear geographic pattern in the floor status of

[21] Rural-area hospitals account for approximately 28 percent (9,525 out of 33,424) of the hospital-year observations in my sample.

[22] Gray areas are urban CBSAs with no acute care, short-term inpatient facilities that serve Medicare patients.

Figure 3: Distribution of Normalized Wage Index Values, 2005-2015



Notes: This figure plots the frequency of normalized wage index occurrences in the 4,763 urban CBSA-state-year observations between FY 2005 and FY 2015. The red, vertical line is at zero; areas to its left are below the rural floor.

Table 2: Normalized Wage Index Statistics

	CBSA-State -Year	Hospital -Year
Mean	0.071	0.111
Std. Dev.	0.101	0.121
1st Quar.	0.019	0.040
Median	0.068	0.097
3rd Quar.	0.123	0.161
Prob. Neg.	0.177	0.126
Obs.	4,712	21,736

Notes: This table lists the mean, standard deviation, quartiles, and probability of a negative value of the normalized wage index at the CBSA-state-year and hospital-year levels.

CBSAs. For example, San Diego, CA has a negative NWI in FY 2013 while Houston, TX falls significantly above the rural floor of its state even though San Diego has a much higher baseline wage index than Houston. This kind of variation between states in a given year explains more than one quarter of the variation in the NWI, with the remainder being driven by intra-state-year variation in local labor market conditions.

4.2 Hospital Characteristics and Finances

Most outcomes considered in this paper are measured at the hospital by year level. I restrict my attention to the roughly 2,400 acute, short-term, general medical and surgical hospitals in urban areas. I primarily draw on Medicare cost reports submitted annually by every hospital receiving any Medicare reimbursement for data. These cost reports are generated in the billing reconciliation process between hospitals and Medicare each fiscal year. In addition to the data involved in calculating the revenue to be collected from Medicare (e.g. Medicare patient discharges and revenue by reimbursement component), the reports provide data on hospital characteristics (like size and ownership status). Hospitals also submit standardized financial statements (a balance sheet, income statement, and analysis of changes in capital asset balances) as part of the report.[23]

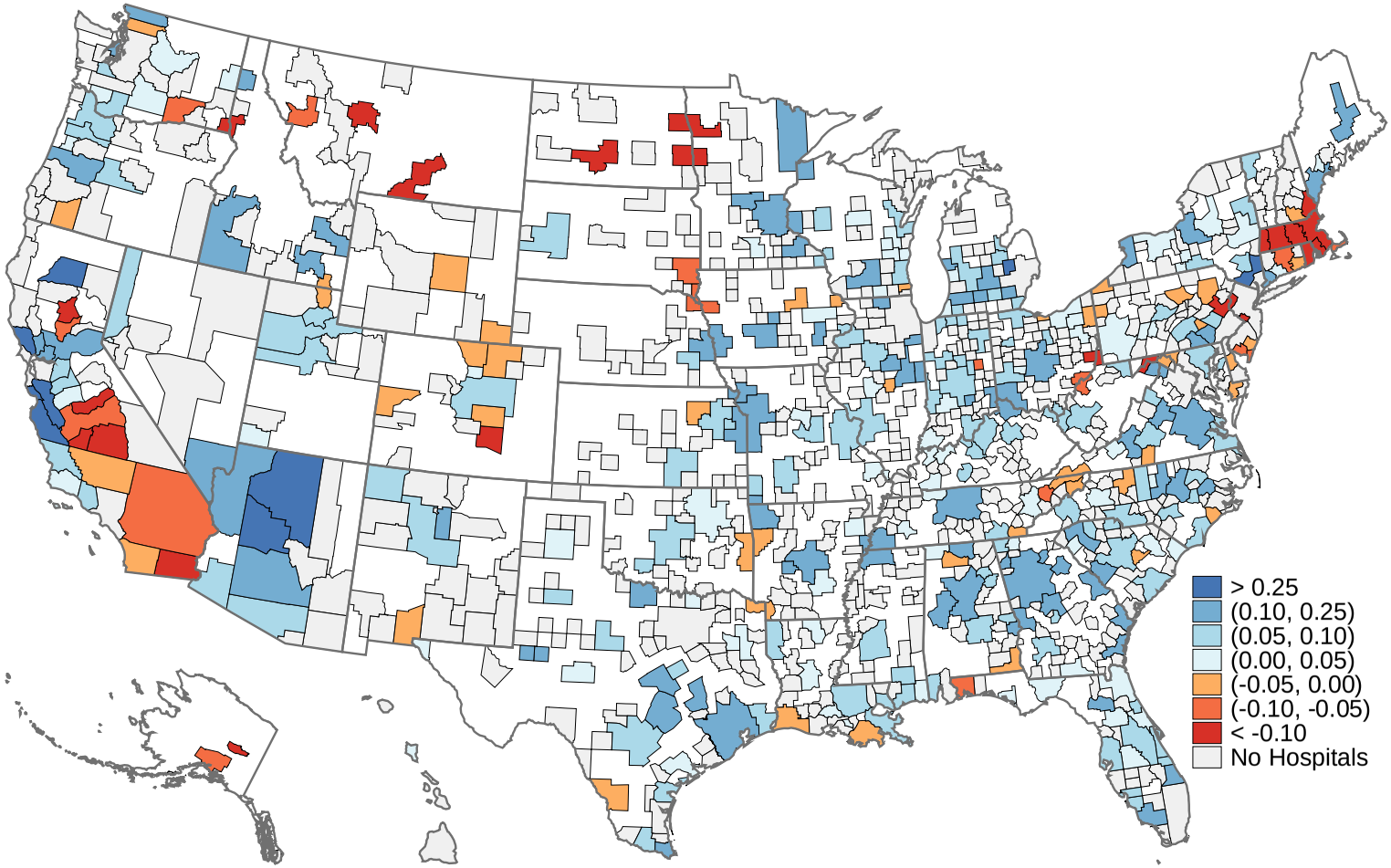
Several complicating factors arise when using the Medicare cost reports in practice. Because reports are often filled out by hand, there are many typos in the state and county fields. I correct for these errors by hand; more than 15 percent of observations are modified in some way. Second, hospitals can submit cost reports that span more than one fiscal year.[24] Because Medicare reimbursement policy changes discretely by fiscal year and not by hospital reporting period, I allocate variables that measure flows (e.g. utilization, revenue, expenses, etc.) to each fiscal year in proportion to the fraction of the reporting period that falls in that year. To the extent this introduces measurement error into the data, it would cut against finding significant results. Finally, the financial data in these reports are prone to outliers (Dranove et al. 2014; Dafny 2005). Following Krinsky et al. (2016), I drop a number of hospitals that are small, missing data, or have internal inconsistencies in calculation (see the online appendix for formal details). After these adjustments, the baseline sample includes 23,899 facility-years between FY 2005 and FY 2014.

Table 3 presents some descriptive statistics for my sample of hospitals. Columns 1 and 2 give means and standard deviations for the full sample of hospitals, and columns 3 and 4 give the same for the set of hospitals in areas with a wage index below their state's rural floor. More than 60 percent of hospitals in the sample are operated on a not-for-profit basis, while roughly 25 percent are owned by for-profit entities. The average hospital has 183 beds and approximately half of its patients are insured by Medicare. Measured

[23]The financial statements are not required to be audited by a third party, but CMS conducts reviews of every submitted cost report.

[24]The federal fiscal year for Medicare runs from October 1st through September 30th. Fiscal years are referenced by the calendar year of their January through September portion.

Figure 4: Normalized Wage Index by CBSA



Notes: This map plots the geographic distribution of the normalized wage index in FY 2012. Blue areas have a wage index greater than the rural floor while the wage index is set at the floor in red-orange areas. Gray areas are CBSA with no hospitals serving Medicare patients, and white areas are the "rural" area of each state. The wage index for hospitals in these white areas sets the rural floor for each state.

Table 3: Hospital Characteristics

	Full Sample		Binding Floor	
	Mean	Std. Dev.	Mean	Std. Dev.
	(1)	(2)	(3)	(4)
Ownership: NFP	0.650	0.477	0.663	0.473
Ownership: For Profit	0.226	0.418	0.216	0.411
Ownership: Gov't	0.124	0.329	0.122	0.327
Medicare Dishcarges	3,979	3,318	3,605	2,758
Medicaid Discharges	1,731	2,263	1,547	1,815
Other Discharges	6,686	6,556	5,991	5,164
Total Discharges	12,448	10,638	11,208	8,100
Medicare LOS	5.10	1.27	5.04	1.16
Medicaid LOS	4.79	2.52	4.73	2.31
Other LOS	4.29	4.01	4.18	2.41
Total LOS	4.51	1.09	4.39	1.04
Hospital Beds	244.1	193.2	220.3	147.6
Medicare Share	0.348	0.123	0.347	0.127
Case Mix Index	1.49	0.28	1.48	0.27
Observations	21,703		2,737	

Notes: This table gives means and standard deviations of hospital characteristics. Columns 1 and 2 use the full sample of data, while columns 3 and 4 restrict the sample to hospitals in areas with a wage index below the rural floor. A discharge occurs when an admitted inpatient is released from the hospital, and an inpatient day (IPD) is a day of inpatient care provided to a patient. In this table, Medicare-specific utilization is counted regardless of patient insurance type (i.e. traditional versus Medicare Advantage).

by beds, discharges, or inpatient days, hospital size is highly variable with a long right tail. Table 3 also reports descriptive statistics for the subset of hospitals where the rural floor binds. These hospitals are slightly smaller on average and slightly more likely to be government owned or not for profit than the overall population of hospitals. The share of patients with Medicare coverage is roughly the same, though, between hospitals with a binding rural floor and those without.

Hospital-level observations are linked to CBSA-level variables (e.g. the normalized wage index) based on their reported (and often corrected) county. Table 4 describes the distribution of several components of the operating portion of the IPPS reimbursement rate. Columns 1 through 3 detail various distributions of the wage index. Column 1 presents the wage index as issued early in the fiscal year as a proposed rule. This wage index is free from adjustments for the rural floor or voluntary hospital status reclassifications. Column 2 summarizes the wage index distribution at the CBSA level after all these adjustments have been made. Column 3 gives the distribution of the same final wage index weighted by the number of hospitals assigned each index value. This distribution reflects the wage index actually used in reimbursement. The hospital-level wage index is drawn from tables provided by CMS relating to the final wage index rule each year. The distributions of these three versions of the wage index are nearly identical (a function of budget neutrality policies), and each is nearly perfectly correlated with the others (pairwise correlations all greater

Table 4: Medicare IPPS Operating Reimbursement Rates

	Wage Index (Unadj.) (1)	Wage Index (CBSA) (2)	Wage Index (Hospital) (3)	Labor Share (4)	Reimb. Rate (Index) (5)	Base Rate (6)	Reimb. Rate (Dollars) (7)
Mean	1.02	1.02	1.03	0.66	1.02	5,055.14	5,216.37
Std. Dev.	0.16	0.16	0.17	0.04	0.12	253.49	645.02
Minimum	0.67	0.71	0.71	0.62	0.82	4,554.25	3,811.63
1st Quartile	0.90	0.90	0.91	0.62	0.94	4,874.49	4,798.15
Median	0.98	0.98	0.99	0.69	0.99	5,128.41	5,073.18
3rd Quartile	1.10	1.11	1.12	0.70	1.09	5,214.02	5,501.85
Maximum	1.76	1.75	1.93	0.71	2.03	5,370.28	10900.78
Observations	21,859						

Notes: This table provides summary statistics for the operating portion of the inpatient prospective payment system (IPPS) Medicare reimbursement rate and the inputs to its calculation. Columns 1 through 3 detail the wage index before and after the rural floor adjustment and after hospital reclassification. The labor share in column 4 and base rate in column 6 combine with the wage index to calculate the total reimbursement in column 7. The reimbursement rate index in column 5 is equal to the reimbursement rate divided by the base rate. All statistics are calculated at the hospital by year level, regardless of the unit at which they vary.

than 0.98).

In order to calculate the reimbursement rate for each hospital, I collect the federally set labor share fraction and base rate for each year from the final rules posted in the Federal Register by CMS each year. Column 4 of Table 4 documents the labor share, or the portion of the reimbursement rate that is adjusted by the wage index and is thus at risk for rural floor adjustments. The labor share ranges from 62 to 71 percent. I calculate a reimbursement rate index equal to $LRP * WI - (1 - LRP)$. This index is the operating portion reimbursement rate before multiplying by the base rate that converts it to dollars. As shown in column 5, the mean of this index is roughly equal to one with a standard deviation of twelve percent. The hospital with the highest reimbursement rate is making two and a half times more per equivalently diagnosed patient than the lowest reimbursement rate hospital. In column 7, this index is converted to dollars by multiplying by the annually adjusted base rate (column 6). The average hospital treating the average-severity patient receives $5,185.79 in operating reimbursement rate. For reference, the average capital reimbursement rate is $427.96, or 8 percent of the operating rate.[25]

Tables 5 and 6 present means and medians of financial data for hospitals in my sample. Table 5 describes the sources of Medicare revenue. The average hospital collects $30.8 million in base revenue through the IPPS program (median $22.3 million). Several programs add to this payment, including the indirect medical education (IME) payment and disproportionate share hospital (DSH) payment. The average total operating revenue through IPPS is $39.7 million (median $27.3 million). Adding a small capital payment, mean inpatient revenue through the IPPS program is over $40 million dollars per year. These figures are somewhat

[25]Summary statistics for the geographic adjustment factor (GAF), base capital rate, and capital reimbursement rate can be found in the online appendix.

Table 5: Medicare Based Hospital Revenue

	Overall		Binding Floor	
	Mean	Median	Mean	Median
	(1)	(2)	(3)	(4)
Part A: Operating Base	32,042.1	23,762.6	29,993.5	24,061.0
Part A: Outlier	1,624.2	640.3	1,376.6	559.9
Part A: Indirect Medical Education	2,864.6	0.0	1,944.7	0.0
Part A: Disproportionate Share	3,918.1	1,766.9	3,511.0	1,782.0
Part A: Operating Total	41,163.2	28,958.1	37,440.5	28,209.8
Part A: Capital Total	3,164.1	2,292.8	2,830.7	2,179.4
Part A: Direct Graduate Medical Education	1,016.5	0.0	596.9	0.0
Part A: Total	46,441.6	32,117.6	41,766.1	31,278.0
Part B: Base	12,285.5	8,216.4	12,462.3	8,880.6
Part B: Total	13,369.6	8,892.7	13,311.8	9,438.1
Total Medicare	59,811.2	41,618.9	55,078.0	41,868.6
Observations	21,859		2,754	

Notes: This table provides the mean and median revenue from Medicare sources for sample hospitals overall (columns 1 and 2) and with a binding rural floor (columns 3 and 4). Base (see equation 7), outlier, indirect medical education (IME), and disproportionate share (DSH) revenue are a subset of operating revenue. Capital and operating revenue account for more than 95 percent of total inpatient revenue through IPPS. All statistics are measured in thousands of dollars.

smaller for hospitals with a binding rural floor, consistent with their smaller size as documented in Table 3.

Table 6 presents income statement summary statistics for hospitals in my sample. The average hospital earns $256 million (median $165 million) in revenues each year, almost exclusively from services rendered to patients. More than 95 percent of these revenues are used to cover expenses; most of these expenses are related to operating the hospital day to day with roughly 40 percent going to salaried employees. This leaves a slim margin of net income that can be used to purchase new assets such as buildings and equipment, used to pay down debt obligations, or added to the hospital treasury. While the median hospital has a net income margin of over 4 percent, the hospital at the first quartile operates at a net loss and the hospital at the third quartile has a nearly nine percent margin. This wide variation in profitability is essentially uncorrelated with the size of the hospital.[26] Besides being smaller than the average hospital, hospitals that fall below the rural floor are similar on most income statement measures. Exceptions include their higher reliance on Medicaid revenue (38.3 versus 30.3 percent of total revenue) and lower overall profitability (3.8 versus 4.6 percent profit margin).

The differences between hospitals in areas with a binding rural wage index floor and those without a binding floor motivate a research design that ensures appropriate comparisons.

[26]For example, the correlation coefficient between the net margin and number of hospital beds is 0.031.

Table 6: Hospital Income Statement

	Overall		Binding Floor	
	Mean	Median	Mean	Median
	(1)	(2)	(3)	(4)
Medicare Revenue	59,811.2	41,618.9	55,078.0	41,868.6
Medicaid Revenue	75,972.2	22,726.8	83,592.6	29,156.1
Total Patient Revenue	243,501.8	163,385.8	217,509.1	162,692.7
Total Revenue	263,193.5	172,315.8	234,921.2	171,827.2
Salary Expenses	95,104.4	61,130.1	88,358.3	65,352.5
Non-Salary Expenses	150,392.0	99,651.9	135,713.1	98,460.3
Operating Expenses	248,033.2	164,089.2	224,288.9	164,780.1
Total Expenses	251,301.2	166,816.6	226,684.4	168,370.2
Net Patient Profit	-4,431.2	-125.1	-6,780.5	-392.5
Total Profit	11,992.5	6,171.6	8,236.1	5,940.9
Observations	21,859		2,754	

Notes: This table provides the mean and median revenue, expenses, and profits for sample hospitals overall (columns 1 and 2) and with a binding rural floor (columns 3 and 4). All statistics are measured in thousands of dollars.

5 Regression Kink and the Rural Floor

5.1 Regression Kink Design

Introduced by Nielsen et al. (2010) to study the effect of financial aid on college enrollment, the regression kink design (RKD) takes advantage of a kink in the intensity of treatment to identify a causal effect. It is similar to the standard regression discontinuity design (RDD) in that it leverages discontinuous changes in treatment at a specific point in a running variable, but the RKD uses a jump in the intensity (first derivative) rather than level of treatment. An RKD must use discontinuous change on the intensive margin of treatment while RDDs can take advantage of changes on the extensive or intensive margin.[27]

The Medicare wage index rural floor policy induces a kink in the wage index and, therefore, in the IPPS reimbursement rate. This kink occurs at zero in the the running variable, the normalized wage index ($NWI_{cst} = WI^{unadj}_{cst} - RF_{st}$). Within a state and year, the wage index changes roughly one for one with the normalized wage index if it is above the rural floor, but below the rural floor the wage index is constant. The change in the wage index due to the rural floor (or "treatment") is zero above the floor but increases one for one as the normalized wage index becomes more *negative*. I use this discontinuity in treatment intensity to estimate the RKD model in equation 8.

$$y_{hcst} = \sum_{p=0}^{2} \alpha_p \left(NWI_{cst}\right)^p + \sum_{p=0}^{2} \beta_p \left(NWI^{+}_{cst}\right)^p + \theta X_h + \gamma_{st} + \varepsilon_{hcst} \tag{8}$$

Following Card et al. (2014) and Card et al. (2015), I use a "local quadratic" specification, fitting quadratic

[27] The intensive margin change RKD can, though, begin precisely at the extensive margin of treatment, as in this setting.

polynomials of outcome y in hospital h located in CBSA c and state s at year t in the normalized wage index on either side of the kink point within a window of the cutoff and comparing the differences in first derivatives. With a cutoff at $NWI = 0$, this difference in derivatives at the cutoff is captured by the estimate for β_1. State by year fixed effects, γ_{st}, are included to appropriately account for differences in the rural floor between states and over time as well as to improve power. The estimate for β_1 can be interpreted as the average marginal effect of the rural floor over each state-year quasi-experiment. I estimate equation 8 using a uniform kernel, and a window of ± 0.075 normalized wage index points. This window is roughly consistent with the mean squared error optimal bandwidth selection algorithm of Imbens and Kalyanaraman (2012) and Calonico et al. (2014).[28] Though outcomes are measured at the hospital by year level, standard errors are clustered at the level of identifying variation (CBSA by state by year). To check robustness, I also include hospital-level controls (X_h) that are fixed or determined prior to the rural floor program implementation in 1998.

5.2 Identification and First Stage Results

The key identifying assumption for the average marginal treatment effect using an RKD is that the relationship between outcomes and the normalized wage index is smooth (at least locally) in the absence of the kink in the wage index (Card et al. 2015). That hospitals cannot precisely manipulate their normalized wage index is necessary for this assumption to hold. The assumption is not violated, however, if hospitals exercise only partial influence on their wage index. Two factors make this condition plausible in this setting. First, while hospitals do have direct influence (subject to having some labor market power) over the wages they pay their nurses and other staff, the wage index assigned by CMS to each hospital is based on the wages that all hospitals in the CBSA pay. Thus a single hospital has diminishing influence on the wage index as the number of hospitals in the area grows. Second, and more importantly, the normalized wage index is determined not only by local wages but also by the wages hospitals pay in the rural parts of the state. Hospitals generally do not have the power to manipulate the wages paid by hospitals in these other areas, often quite far away.[29] Consistent with the identifying assumption, the distribution of the normalized wage index, plotted in Figure 3, is smooth across the cutoff at zero. While there is more distributional mass to the right of the cutoff than to the left, a McCrary (2008) test confirms we cannot reject the null that the distribution is continuous at the cutoff (t = 1.54).

In addition to reporting results from the standard "sharp" regression kink specification in equation 8, I also provide estimates of the effect of the total Medicare reimbursement rate on hospital outcomes. I

[28] Calonico et al. (2014) also propose a bias correction for discontinuity estimates. Estimates and standard errors reflecting this correction can be found in the online appendix.

[29] The Partners HealthCare example in footnote 19 is a notable counterexample to this.

instrument for the reimbursement rate using the kink variation induced by the rural floor in the standard way. This "fuzzy" RK specification scales the sharp RK estimates appropriately to account for the fact that a rural-floor induced change in the wage index at the CBSA level does not translate one for one into changes in the hospital wage index and therefore into the total reimbursement rate. Table 7 formally reports this relationship. Falling one percentage point below the rural floor increases the wage index at the CBSA level by 0.93 percentage points but only 0.53 percentage points at the hospital level. This imperfect pass through reflects the fact that some hospitals in affected CBSAs are not themselves affected by the rural floor because they have otherwise reclassified their wage index under one of the other wage index programs from Table 1. For a hospital with the mean increase in wage index from the rural floor, this shift in the hospital wage index translates into roughly $120 more per discharge ($104 from operating and $16 from capital payment) of an average patient, a three percent increase in reimbursement rate. This first stage relationship persists when controlling above and below the kink for the size of the hospital with number of hospital beds in 1996 (before the wage index adjustments were implemented). The rural floor kink variation satisfies the usual instrumental variables conditions in that it is strongly related to the total reimbursement rate (F statistic = 286.9) and excludable in the sense that its only influence on other hospital outcomes is due to its influence on the reimbursement rate through the wage index.

6 Effects of the Rural Floor on Hospital Patient Volume

6.1 Medicare Patients

Changes in Medicare reimbursement policy have a direct effect on the profitability of Medicare patients to hospitals. To estimate the effect of reimbursement rate changes on the the quantity of Medicare patients treated by hospitals, I estimate a fuzzy regression kink model using the rural floor variation. Column 2 of Table 8 gives baseline estimates for a range of quantity-related outcomes, including Medicare discharges. A one dollar increase in the Medicare reimbursement rate increases the number of annual Medicare discharges by 4.08. Evaluated at the mean reimbursement rate increase of $119.37 from the rural floor, this estimate translates into 486.47 additional patients per year (see column 3), or 12.6 percent of the mean. Adding controls for the hospital size (in beds) to the baseline regression attenuates this estimate (column 4), but standard errors are too large to reject equality between specifications.

The slope of the supply curve for Medicare hospital services is negative, as expected. The slope is also substantial. Measuring supply in number of patients treated, though, masks potential heterogeneity. As the reimbursement rate rises, the average duration of inpatient stay declines. For the average hospital with a

Table 7: Rural Floor Impact on Medicare Reimbursement Rates

		Baseline		With Controls	
	Mean	Coef.	Mean Eff.	Coef.	Mean Eff.
	(1)	(2)	(3)	(4)	(5)
Wage Index (CBSA)	0.97	0.93***	0.05	0.94***	0.05
		(0.02)		(0.02)	
Wage Index (Hospital)	0.98	0.53***	0.03	0.49***	0.03
		(0.07)		(0.07)	
Operating Price (Index)	0.99	0.32***	0.02	0.29***	0.02
		(0.05)		(0.05)	
Operating Price (Dollars)	5,065.34	1,609.43***	90.19	1,477.86***	82.82
		(234.09)		(244.08)	
Capital Price (Index)	0.98	0.66***	0.04	0.67***	0.04
		(0.01)		(0.01)	
Capital Price (Dollars)	413.79	281.72***	15.79	283.70***	15.90
		(4.96)		(4.47)	
Total Price (Dollars)	5,481.99	1,880.67***	105.40	1,753.66***	98.28
		(233.18)		(242.86)	
Log Total Price	8.60	0.40***	0.02	0.37***	0.02
		(0.04)		(0.04)	
Observations		7,246		5,764	
Clusters		1,807		1,758	

Notes: This table presents sharp regression kink (RK) estimates of the effect of the Medicare wage index rural floor on Medicare reimbursement rates. Each row reports the estimation-sample mean (column 1) and two RK estimates for the listed dependent variable. Columns 2 and 3 present standard RK estimates. To the standard specification, the estimates in columns 4 and 5 add controls above and below the kink for hospital size using the number of pre-period hospital beds. The estimated change in slope around the wage index kink is reported in columns 2 and 4; columns 3 and 5 scale these estimates to the mean wage index increase for sub-floor hospitals (5.6 percent). The adjusted R^2 for the standard model ranges between 0.958 and 0.999 and between 0.963 and 0.999 for the model with controls. All reported regressions include state by year fixed effects. Standard errors (in parentheses) are clustered at the CBSA by state by year level. Stars denote significance at the 10% (*), 5% (**), and 1% (***) level.

Table 8: Impact of Medicare Reimbursement on Inpatient Treatment

		Baseline		With Controls	
	Mean	Coef.	Mean Eff.	Coef.	Mean Eff.
	(1)	(2)	(3)	(4)	(5)
Medicare Discharges	3,848.41	4.60***	484.51	0.89	93.37
		(1.72)		(2.57)	
Medicaid Discharges	1,601.89	4.32***	455.45	3.86**	406.57
		(1.28)		(1.78)	
Other Discharges	6,076.69	11.77***	1,240.61	6.47	682.24
		(3.52)		(4.83)	
Total Discharges	11,568.62	20.64***	2,175.80	11.09	1,169.09
		(5.63)		(8.11)	
Medicare Stay Length	5.07	-0.00***	-0.34	-0.00***	-0.36
		(0.00)		(0.00)	
Medicaid Stay Length	9.47	0.09	9.20	0.11	11.95
		(0.10)		(0.13)	
Other Stay Length	4.36	-0.01***	-1.24	-0.01***	-1.47
		(0.00)		(0.00)	
Total Stay Length	4.49	-0.00***	-0.32	-0.00***	-0.30
		(0.00)		(0.00)	
Case Mix Index	1.48	0.00	0.02	-0.00*	-0.04
		(0.00)		(0.00)	
Observations		7,245		5,764	
Clusters		1,807		1,758	

Notes: This table presents fuzzy regression kink (RK) estimates of the effect of the Medicare reimbursement rate on characteristics of patients admitted to the hospital. Each row reports the estimation-sample mean (column 1) and two RK estimates for the listed dependent variable. Columns 2 and 3 present standard RK estimates. To the standard specification, the estimates in columns 4 and 5 add controls above and below the kink for hospital size using the number of pre-period hospital beds. The estimated change in slope around the wage index kink is reported in columns 2 and 4; columns 3 and 5 scale these estimates to the mean estimated reimbursement rate increase for sub-floor hospitals ($105.4). The adjusted R^2 for the standard model ranges between 0-.04 and 0.085 and between 0-.044 and 0.444 for the model with controls. All reported regressions include state by year fixed effects. Standard errors (in parentheses) are clustered at the CBSA by state by year level. Stars denote significance at the 10% (*), 5% (**), and 1% (***) level.

rate boost from the rural floor, length of stay declines by a third of a day or seven percent. On the other hand, the case mix index, an index of Medicare patient diagnostic severity, is unchanged by variation in the payment rate. Though patients spend less time in the hospital when reimbursement is higher, they are not healthier, on average, at the time they are admitted. Decreases in the average Medicare length of stay could result from an overall decrease in treatment intensity. Increased financial incentives to care for Medicare patients leads hospitals to admit more of them, but they can only accommodate the increase by rationing their limited capital resources, such as bed space. Alternatively, it could be the case that the marginal Medicare patients are able to be treated more quickly than the average patient, leading to a decline in the average length of stay. If so, the change in required resources must be unrelated to the diagnostic severity measured by the case mix index.

Potentially consistent with either of these stories, outpatient Medicare (Part B) revenue is higher for hospitals with higher inpatient (Part A) reimbursement rates. Table 9 presents estimates of the effects of Part A reimbursement rate changes on Medicare revenue. A one dollar increase in the inpatient reimbursement rate is associated with $21,000 more outpatient Medicare revenue, totaling more than $2.5 million for the average rural floor hospital. The indirect effect of changes in price for one type of service on other services provided to the same patient class can be rationalized by hospital targeting these patients, increased follow-up care following a hospital admission, or a combination of the two. Some hospital strategies for attracting additional Medicare patients into their inpatient ranks (e.g. advertising) could also attract outpatients as well. Furthermore, inpatient care often precipitates follow-up checks that occur in an outpatient setting. The direct effect of increasing inpatient utilization may be in part responsible for increased outpatient utilization and hospital revenue.

The normative implications of the impacts of reimbursement rate changes on Medicare patients depend on how these patients would have otherwise been treated. Increased utilization might be welcomed by those concerned with access to medical care for Medicare patients. On the other hand, doctors and hospital administrators may take advantage of inflated prices and admit patients whose marginal benefit of treatment is below the marginal cost of hospital admission. Balancing these countervailing concerns is at the heart of the difficulty in centrally administering prices, and precisely measuring where current policy falls between the two is beyond the scope of this paper.

6.2 Rural Floor Spillovers to Non-Medicare Patients

While changes to the Medicare reimbursement rate have both direct and indirect effects on Medicare patients, Medicare payment policy also has spillover effects on other patient populations at the hospital. Table 8 details

Table 9: Impact of Medicare Reimbursement on Medicare Revenue

		Baseline		With Controls	
	Mean	Coef.	Mean Eff.	Coef.	Mean Eff.
	(1)	(2)	(3)	(4)	(5)
Part A: Operating Base	29,755.50	47.09***	4,963.02	13.57	1,430.30
		(14.84)		(22.62)	
Part A: Operating Total	37,226.83	52.96***	5,581.40	14.19	1,496.08
		(19.47)		(29.91)	
Part A: Capital Total	2,859.20	4.23***	445.31	1.38	145.73
		(1.44)		(2.24)	
Part A: Total	41,698.13	58.44***	6,159.72	15.61	1,644.73
		(21.63)		(33.80)	
Part B: Base	11,407.12	19.73***	2,079.11	4.72	497.37
		(6.24)		(10.30)	
Part B: Total	12,322.69	23.86***	2,514.62	9.19	968.65
		(6.70)		(10.95)	
Total Medicare	54,020.82	82.30***	8,674.34	24.80	2,613.37
		(27.28)		(43.89)	
Observations		7,246		5,764	
Clusters		1,807		1,758	

Notes: This table presents fuzzy regression kink (RK) estimates of the effect of the Medicare reimbursement rate on revenue from Medicare patients. Each row reports the estimation-sample mean (column 1) and two RK estimates for the listed dependent variable. Columns 2 and 3 present standard RK estimates. To the standard specification, the estimates in columns 4 and 5 add controls above and below the kink for hospital size using the number of pre-period hospital beds. The estimated change in slope around the wage index kink is reported in columns 2 and 4; columns 3 and 5 scale these estimates to the mean estimated reimbursement rate increase for sub-floor hospitals ($105.4). The adjusted R^2 for the standard model ranges between 0.041 and 0.092 and between 0.328 and 0.391 for the model with controls. All reported regressions include state by year fixed effects. Standard errors (in parentheses) are clustered at the CBSA by state by year level. Outcomes are measured in thousands of dollars. Stars denote significance at the 10% (*), 5% (**), and 1% (***) level.

the impact of changes in the Medicare reimbursement rate on the number of annual Medicaid discharges and non-Medicare or Medicaid (hereafter other or privately insured) discharges. A one dollar increase in the Medicare reimbursement rate increases the number of Medicaid admissions by 3.81 (28 percent) for an average of 454 additional Medicaid patients due to the rural floor. This effect is robust to including controls for hospital size. The impact of the Medicare price change on average length of hospital stay for Medicaid patients is measured with too much noise to make any inference.

Similar to the spillover effect onto Medicaid patients, hospitals see a rise in privately insured patients as well. This effect is larger in magnitude than either the effect on Medicare or the effect on Medicaid patients at 10.3 more patient per dollar increase in Medicare prices of a similar percentage change (20 percent). The average length of stay for a privately insured patient at a rural floor affected hospital is 1.24 days shorter than it otherwise would have been in the absence of the rural floor. This strong, nearly 30 percent decline in private stay lengths for the group of patients accounting for more than half of all hospital discharges explains how all patient categories can see increases in quantity without running into hospital capacity constraints.

Previous work considering potential spillover impacts of Medicare reimbursement rate policy on other patients almost solely focused on prices. The cost shifting literature argues that hospitals would make up for lost revenue induced by lower Medicare rates by increasing the rates charged to private patients.[30] In response, papers using the maximizing margins model showed that such price increases were inconsistent with either profit or revenue maximization. Less attention has been given to the possibility for quantity spillovers. The maximizing margins model predicts a negative quantity spillover from increasing Medicare reimbursement rates. The estimates of this section strongly reject that prediction. However, these results also do not support the cost shifting theory. The implied impact on revenue per patient of the rural floor are positive, not negative as the cost shifting theory would predict. Existing models of hospital patient mix are not flexible enough to accommodate all empirical facts.

The key assumption driving the negative quantity spillover prediction of the maximizing margins model is that all quantities enter additively into a smooth cost function. Relaxing either component of that assumption is enough to reverse the prediction.[31] Consider, for example, a hospital that requires additional fixed investment in order to expand capacity in order to accommodate any new patients. Small increases in the Medicare reimbursement rate might not be large enough to warrant paying the fixed cost, and rate changes large enough to cause capacity expansion may also cause re-optimization of patient mix with both private and Medicare patients increasing some of the new capacity.

[30] More precisely, much of the early empirical work on cost shifting focused on hospitals making up lost Medicare revenue from the privately insured. The later debated assertion became that hospitals would raise prices on privately insured patients, though the initial findings only supported the weaker revenue claim.

[31] See the appendix for consideration of a cost function where Medicare and private quantity are not perfect substitutes in cost.

Another potential mechanism may be changes in Medicare reimbursements changing hospitals' negotiations with private insurers. Hospitals and private insurers often take Medicare prices as a baseline in negotiation their own contracts (Clemens and Gottlieb 2017), with many specifying their rates in "percentage over Medicare" terms (Capps et al. 2017). A typical contract might be for "150 percent of Medicare." In the short term, this contract structure implies a mechanical, direct, and greater than one-for-one pass through of changes in Medicare prices to private reimbursement rates. Renegotiation of hospital-insurer contracts should erode this impact over time, but to the extent patients and payers suffer from inattention or inability to renegotiate every contract with efficiently, higher Medicare reimbursement could effectively strengthen the hospital bargaining position.

Finally, Medicaid patients are generally the least profitable population for hospitals due to low reimbursement rates, but also are most likely to be indigent. In the reverse of the cost shifting story, hospitals with (at least partially) charitable motives may use extra Medicare revenue to cross-subsidize Medicaid utilization. Thus, increases in Medicare payment rates could increase the number of Medicaid patients a hospital is willing to treat.

7 Financial Consequences of Rural Floor Policy for Hospitals

The Medicare rural floor increases Medicare reimbursement rates for some hospitals, and leads to higher utilization across all patient populations. These increases translate into substantially more hospital revenue. Table 9 summarizes estimates for various measures of inpatient and outpatient Medicare revenue. A one dollar increase in inpatient reimbursement rates leads to a $46,780 increase in the operating portion of IPPS revenue and $3,740 more in the capital portion, for more than $50,000 more revenue per year. The average rural floor hospital with a $119.37 reimbursement rate increase receives more than $6 million dollars in Medicare inpatient revenue alone. These hospitals also receive more than $2.5 million in Medicare outpatient revenue for a total Medicare transfer of $8.7 million. These estimates are attenuated somewhat after including hospital size controls, but the point estimates still represent economically significant hospital revenue gains.

Table 10 puts these gains in the context of other hospital financial outcomes. In addition to a boost in Medicare revenue, utilization increase lead to more Medicaid ($17.4 million) and private ($18.7 million) revenue as well. Though standard errors are large, point estimates indicate average rural floor gains of $44.7 million in operating (patient) revenue and $54.2 million overall. These increases are substantial expansions of hospital budgets (21 and 24 percent, respectively).

As the revenue gains are driven in large part by utilization increases, it is not surprising that much of the new revenue is spent on providing patient care. Operating expenses increase $345,590 per dollar increase

Table 10: Impact of Medicare Reimbursement on Hospital Income and Expenses

		Baseline		With Controls	
	Mean	Coef.	Mean Eff.	Coef.	Mean Eff.
	(1)	(2)	(3)	(4)	(5)
Medicare Revenue	54,020.82	82.30***	8,674.34	24.80	2,613.37
		(27.28)		(43.89)	
Medicaid Revenue	67,334.17	165.97**	17,492.54	155.67	16,406.50
		(80.82)		(114.93)	
Total Patient Revenue	213,582.34	425.06***	44,799.65	173.52	18,288.61
		(120.63)		(197.03)	
Total Revenue	229,430.62	515.26***	54,305.63	240.49	25,346.83
		(127.23)		(212.81)	
Salary Expenses	82,498.55	164.08***	17,292.86	43.56	4,591.17
		(46.40)		(79.29)	
Non-Salary Expenses	131,991.91	235.96***	24,868.88	41.11	4,332.55
		(73.15)		(120.99)	
Operating Expenses	217,335.58	392.75***	41,393.61	127.76	13,465.72
		(112.50)		(203.31)	
Total Expenses	220,447.90	410.27***	43,240.65	124.44	13,114.99
		(114.35)		(205.04)	
Net Patient Profit	-3,733.67	32.97	3,475.33	45.26	4,769.93
		(41.37)		(54.44)	
Total Profit	9,002.29	105.64***	11,134.27	115.55**	12,178.89
		(38.06)		(50.06)	
Observations		7,246		5,764	
Clusters		1,807		1,758	

Notes: This table presents fuzzy regression kink (RK) estimates of the effect of the Medicare reimbursement rate on hospital income and expenses. Each row reports the estimation-sample mean (column 1) and two RK estimates for the listed dependent variable. Columns 2 and 3 present standard RK estimates. To the standard specification, the estimates in columns 4 and 5 add controls above and below the kink for hospital size using the number of pre-period hospital beds. The estimated change in slope around the wage index kink is reported in columns 2 and 4; columns 3 and 5 scale these estimates to the mean estimated reimbursement rate increase for sub-floor hospitals ($105.4). The adjusted R^2 for the standard model ranges between 0-.024 and 0.057 and between 0-.028 and 0.378 for the model with controls. All reported regressions include state by year fixed effects. Standard errors (in parentheses) are clustered at the CBSA by state by year level. Outcomes are measured in thousands of dollars. Stars denote significance at the 10% (*), 5% (**), and 1% (***) level.

in Medicare reimbursement rate, or 92 percent of the increase in operating revenue. Employee salaries are responsible for 41 percent of these expenses, only slightly more than their 38 percent overall share of expenses. The remaining operating expenses are just large enough for the average rural floor hospital to offset the prevailing average net operating loss of $3.7 million. I estimate a net gain in total profit of $11 million, but standard errors are too large to further explore the final allocation of these profits.

8 Conclusion

Understanding the ramifications of changing Medicare reimbursement rates on Medicare beneficiaries and beyond is critical for balancing the complex incentives of hospitals and patients with the fiscal and social objectives of the public insurance program, but the endogenous nature of most variation in these prices makes credible empirical work difficult. Using a quirk in the geographic adjustment of Medicare rates, I estimate the impact of marginal changes in Medicare payments on utilization and financial outcomes for Medicare, Medicaid, and privately-insured patients.

Increases in Medicare reimbursement rates lead to more utilization for patients with all classes of insurance. Medicare beneficiaries are admitted as hospital inpatients more frequently when reimbursement for their care increases, but hospitals treat them for shorter stays. The normative implications of these facts critically depend on the counterfactual treatment of the marginally admitted patients. Higher reimbursement rates may improve access to care for Medicare patients but may also entice hospitals to admit patients whose marginal benefit of additional treatment does not exceed the social cost of additional medical expenses associated with an inpatient stay. Beyond the pool of Medicare patients, I document previously unstudied relationships between Medicare prices and hospital utilization by Medicaid and privately-insured patients. These effects of Medicare policy are not incorporated in standard economic models of patient mix and, until now, have not been part of the policy dialogue. Increased prices and utilization lead to a substantial expansion of hospital revenue. This revenue is almost exclusively used for patient care, though hospitals use a small fraction of it to cover operating losses.

When policy makers consider changing Medicare payment rates, the debate usually centers around federal cost savings, Medicare patient access, and price spillovers to the privately insured. The evidence in this paper suggests that quantity spillovers to patients with Medicaid and private coverage should be added to the dialogue. Signing the welfare effects of these spillovers requires understanding whether the additional utilization alleviates these harmful access restrictions or exacerbates overuse of the medical system. Furthermore, reductions in average stay lengths should give policy makers pause before embracing these spillovers as a social benefit of higher Medicare payments. Additional study of how hospitals adjust their organization

and treatment protocols in order to achieve greater capacity, including the impact of these on patient health (e.g. mortality, morbidity, hospital readmissions), is an important direction for future work.

Though I document strong revenue effects of Medicare reimbursement rate increases, the Medicare rural floor policy is budget neutral from the perspective of the federal government. The hospital benefits of increased rates in some areas that I document are reversed in aggregate by lower rates elsewhere. This redistribution is unusual in that it not only redistributes from high-wage urban to low-wage urban areas, a scheme that could potentially be justified with a traditional social welfare function, but also pulls funds away from rural area hospitals. Other federal programs explicitly shift resources to rural hospitals in order to ensure adequate access to and quality of health care. The wage index rural floor acts at cross purposes with these programs. The rural floor creates concentrated benefits and diffuse costs, a feature that perhaps explains its persistence. However, the absence of empirical or economic motivation suggest Medicare regulators may do well to revisit their rationale for this policy.

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Appendix

A Extending the Cost Function in the Maximizing Margins Model

A.1 Differential cost of treatment between Medicare and private patients

Let $\theta > 0$ represent a wedge between the cost of a Medicare patient and a privately insured patient to treat. Then the total cost is equal to $C\left(Q_{PRI} + \theta Q_{MCR}\right)$ and the first order conditions for profit maximization are

$$C'\left(Q_{PRI} + \theta Q_{MCR}\right) = P_{MCR}/\theta \tag{9}$$

$$C'\left(Q_{PRI} + \theta Q_{MCR}\right) = \frac{\partial P}{\partial Q_{PRI}} Q_{PRI} + P\left(Q_{PRI}\right) \tag{10}$$

These conditions may be combined to form the analog of equation 4:

$$P_{MCR} = \theta \left[\frac{\partial P}{\partial Q_{PRI}} Q_{PRI} + P\left(Q_{PRI}\right)\right]$$

Notice that the only change in this condition is θ scaling the degree of the private quantity response to Medicare prices. Thus the negative quantity prediction is unaffected.

A.2 Non-additivity in the cost function

Consider a general cost function of private and Medicare quantity such that hospital profits are

$$\Pi = P_{MCR} Q_{MCR} + P_{PRI}\left(Q_{PRI}\right) Q_{PRI} - C\left(Q_{MCR}, Q_{PRI}\right)$$

First order conditions for optimization are

$$\frac{\partial C}{\partial Q_{MCR}}\left(Q_{MCR}, Q_{PRI}\right) = P_{MCR}$$
$$\frac{\partial C}{\partial Q_{PRI}}\left(Q_{MCR}, Q_{PRI}\right) = \frac{\partial P}{\partial Q_{PRI}} Q_{PRI} + P\left(Q_{PRI}\right)$$

For convenience, let $MR\left(Q_{PRI}\right) \equiv \frac{\partial P}{\partial Q_{PRI}} Q_{PRI} + P\left(Q_{PRI}\right)$ be the marginal revenue of private patients. In order to obtain a prediction for dQ_{PRI}/dP_{MCR}, I totally differentiate both equations and rearrange terms

to form the system

$$\begin{bmatrix} dP_{MCR} \\ 0 \end{bmatrix} = \begin{bmatrix} \frac{\partial^2 C}{\partial Q_{MCR} \partial Q_{PRI}} & \frac{\partial^2 C}{\partial Q_{MCR}^2} \\ \left(\frac{\partial MR}{\partial Q_{PRI}} - \frac{\partial^2 C}{\partial Q_{PRI}^2} \right) & \frac{\partial^2 C}{\partial Q_{MCR} \partial Q_{PRI}} \end{bmatrix} \begin{bmatrix} dQ_{PRI} \\ dQ_{MCR} \end{bmatrix}$$

By Cramer's Rule

$$\frac{dQ_{PRI}}{dP_{MCR}} = \left(\frac{\partial^2 C}{\partial Q_{MCR} \partial Q_{PRI}} \right) / \left[\left(\frac{\partial MR}{\partial Q_{PRI}} - \frac{\partial^2 C}{\partial Q_{PRI}^2} \right) \left(\frac{\partial^2 C}{\partial Q_{MCR}^2} \right) + \left(\frac{\partial^2 C}{\partial Q_{MCR} \partial Q_{PRI}} \right)^2 \right]$$

The sign of this comparative static is ambiguous. If $\left(\frac{\partial MR}{\partial Q_{PRI}} - \frac{\partial^2 C}{\partial Q_{PRI}^2} \right) \geq 0$ and the cost function is convex in the Medicare quantity, then

$$\text{sign} \left(\frac{dQ_{PRI}}{dP_{MCR}} \right) = \text{sign} \left(\frac{\partial^2 C}{\partial Q_{MCR} \partial Q_{PRI}} \right)$$

In either case, the sharp prediction that an increase in the Medicare price leads to a decline in the quantity of private patients treated does not hold with a general cost function.

B Fiscal Year 2010 State Rural Floor Budget Neutrality Factors

This table lists budget neutrality factors by state for fiscal year 2010 as described in Section 3.2.

State	Rural Floor Budget Neutrality Adjustment Factor		State	Rural Floor Budget Neutrality Adjustment Factor
Alabama	0.99835		Montana	0.99835
Alaska	0.99835		Nebraska	0.99835
Arizona	0.99835		Nevada	0.99835
Arkansas	0.99835		New Hampshire	0.99698
California	0.99415		New Jersey **	0.98437
Colorado	0.99413		New Mexico	0.99576
Connecticut	0.97887		New York	0.99836
Delaware	0.99835		North Carolina	0.99833
Washington, D.C.	0.99835		North Dakota	0.99668
Florida	0.99755		Ohio	0.99783
Georgia	0.99835		Oklahoma	0.99835
Hawaii	0.99835		Oregon	0.99705
Idaho	0.99835		Pennsylvania	0.99812
Illinois	0.99835		Rhode Island	0.99835
Indiana	0.99813		South Carolina	0.99778
Iowa	0.99767		South Dakota	0.99835
Kansas	0.99829		Tennessee	0.99691
Kentucky	0.99835		Texas	0.99835
Louisiana	0.99835		Utah	0.99835
Maine	0.99835		Vermont	0.99835
Maryland *	— — —		Virginia	0.99835
Massachusetts	0.99835		Washington	0.99792
Michigan	0.99835		West Virginia	0.99714
Minnesota	0.99835		Wisconsin	0.99816
Mississippi	0.99835		Wyoming	0.99835
Missouri	0.99835			

* Maryland hospitals are waved from IPPS rate setting this year.

** The rural floor budget neutrality factor for New Jersey is based on an imputed floor. Source: CMS MLN Matters Number MM6634 (Revised).

C Sharp Regression Kink (Reduced Form) Results

Table 11: Rural Floor Impact on Inpatient Treatment

		Baseline		With Controls	
	Mean	Coef.	Mean Eff.	Coef.	Mean Eff.
	(1)	(2)	(3)	(4)	(5)
Medicare Discharges	3,848.41	2,583.36	144.77	3,733.85	209.25
		(3,234.02)		(2,832.91)	
Medicaid Discharges	1,601.89	5,761.51**	322.88	8,425.80***	472.19
		(2,362.49)		(2,530.33)	
Other Discharges	6,076.69	18,594.50***	1,042.06	20,842.34***	1,168.03
		(7,012.12)		(5,002.32)	
Total Discharges	11,568.62	27,205.60***	1,524.64	33,006.10***	1,849.70
		(10,545.25)		(7,131.12)	
Medicare Stay Length	5.07	-5.89***	-0.33	-4.82***	-0.27
		(1.56)		(1.55)	
Medicaid Stay Length	9.47	182.95	10.25	186.34	10.44
		(160.89)		(191.31)	
Other Stay Length	4.36	-19.91***	-1.12	-21.44***	-1.20
		(5.47)		(6.09)	
Total Stay Length	4.49	-5.91***	-0.33	-4.36***	-0.24
		(1.40)		(1.40)	
Case Mix Index	1.48	0.58*	0.03	-0.19	-0.01
		(0.30)		(0.26)	
Observations		8,088		6,470	
Clusters		2,017		1,964	

Notes: This table presents sharp regression kink (RK) estimates of the effect of the Medicare wage index rural floor on characteristics of patients admitted to the hospital. Each row reports the estimation-sample mean (column 1) and two RK estimates for the listed dependent variable. Columns 2 and 3 present standard RK estimates. To the standard specification, the estimates in columns 4 and 5 add controls above and below the kink for hospital size using the number of pre-period hospital beds. The estimated change in slope around the wage index kink is reported in columns 2 and 4; columns 3 and 5 scale these estimates to the mean wage index increase for sub-floor hospitals (5.6 percent). The adjusted R^2 for the standard model ranges between 0-.012 and 0.175 and between 0-.005 and 0.468 for the model with controls. All reported regressions include state by year fixed effects. Standard errors (in parentheses) are clustered at the CBSA by state by year level. Stars denote significance at the 10% (*), 5% (**), and 1% (***) level.

Table 12: Rural Floor Impact on Medicare Revenue

		Baseline		With Controls	
	Mean	Coef.	Mean Eff.	Coef.	Mean Eff.
	(1)	(2)	(3)	(4)	(5)
Part A: Operating Base	29,755.50	46,521.40*	2,607.12	60,923.83***	3,414.25
		(26,984.06)		(23,577.57)	
Part A: Operating Total	37,226.83	59,532.46*	3,336.27	87,773.61***	4,918.94
		(35,052.61)		(27,840.14)	
Part A: Capital Total	2,859.20	4,593.71*	257.44	6,748.79***	378.21
		(2,651.61)		(2,169.06)	
Part A: Total	41,698.13	67,515.79*	3,783.67	99,726.57***	5,588.80
		(39,316.64)		(30,476.95)	
Part B: Base	11,407.12	22,413.35*	1,256.07	29,601.48**	1,658.90
		(11,533.76)		(12,830.82)	
Part B: Total	12,322.69	32,119.90***	1,800.04	39,298.18***	2,202.32
		(12,159.07)		(13,111.08)	
Total Medicare	54,020.82	99,635.69**	5,583.71	139,024.75***	7,791.12
		(49,237.66)		(41,378.55)	
Observations		8,089		6,470	
Clusters		2,017		1,964	

Notes: This table presents sharp regression kink (RK) estimates of the effect of the Medicare wage index rural floor on revenue from Medicare patients. Each row reports the estimation-sample mean (column 1) and two RK estimates for the listed dependent variable. Columns 2 and 3 present standard RK estimates. To the standard specification, the estimates in columns 4 and 5 add controls above and below the kink for hospital size using the number of pre-period hospital beds. The estimated change in slope around the wage index kink is reported in columns 2 and 4; columns 3 and 5 scale these estimates to the mean wage index increase for sub-floor hospitals (5.6 percent). The adjusted R^2 for the standard model ranges between 0.046 and 0.11 and between 0.338 and 0.4 for the model with controls. All reported regressions include state by year fixed effects. Standard errors (in parentheses) are clustered at the CBSA by state by year level. Outcomes are measured in thousands of dollars. Stars denote significance at the 10% (*), 5% (**), and 1% (***) level.

Table 13: Rural Floor Impact on Hospital Income and Expenses

		Baseline		With Controls	
	Mean	Coef.	Mean Eff.	Coef.	Mean Eff.
	(1)	(2)	(3)	(4)	(5)
Medicare Revenue	54,020.82	99,635.69**	5,583.71	139,024.75***	7,791.12
		(49,237.66)		(41,378.55)	
Medicaid Revenue	67,334.17	316,452.33**	17,734.39	527,844.73***	29,581.09
		(141,350.74)		(158,159.97)	
Total Patient Revenue	213,582.34	613,246.84***	34,367.13	721,740.42***	40,447.25
		(216,871.09)		(192,798.44)	
Total Revenue	229,430.62	788,438.24***	44,185.08	928,100.93***	52,011.96
		(222,137.68)		(201,523.19)	
Salary Expenses	82,498.55	241,003.71***	13,506.15	289,443.15***	16,220.76
		(84,678.28)		(73,574.63)	
Non-Salary Expenses	131,991.91	397,430.52***	22,272.51	441,888.66***	24,764.00
		(134,354.45)		(107,538.10)	
Operating Expenses	217,335.58	629,687.37***	35,288.48	764,696.01***	42,854.54
		(204,927.84)		(181,614.25)	
Total Expenses	220,447.90	657,569.29***	36,851.02	767,147.41***	42,991.92
		(206,788.05)		(182,554.65)	
Net Patient Profit	-3,733.67	-16,298.94	-913.41	-43,972.68	-2,464.28
		(84,892.79)		(87,562.11)	
Total Profit	9,002.29	131,010.53*	7,342.00	159,936.44**	8,963.04
		(73,816.25)		(78,812.42)	
Observations		8,089		6,470	
Clusters		2,017		1,964	

Notes: This table presents sharp regression kink (RK) estimates of the effect of the Medicare wage index rural floor on hospital income and expenses. Each row reports the estimation-sample mean (column 1) and two RK estimates for the listed dependent variable. Columns 2 and 3 present standard RK estimates. To the standard specification, the estimates in columns 4 and 5 add controls above and below the kink for hospital size using the number of pre-period hospital beds. The estimated change in slope around the wage index kink is reported in columns 2 and 4; columns 3 and 5 scale these estimates to the mean wage index increase for sub-floor hospitals (5.6 percent). The adjusted R^2 for the standard model ranges between 0-.01 and 0.066 and between 0-.019 and 0.392 for the model with controls. All reported regressions include state by year fixed effects. Standard errors (in parentheses) are clustered at the CBSA by state by year level. Outcomes are measured in thousands of dollars. Stars denote significance at the 10% (*), 5% (**), and 1% (***) level.