Supplemental Material

Data S1.

Supplemental Methods

Decompositions

As discussed in the Methods section of the paper, our goal was to decompose the overall gap between whites and blacks in the use of hospitals of varying quality levels into two components: (1) racial differences in geographic access to hospitals of different quality levels and (2) racial differences in hospital choice behavior. We conceptualize the first component as the difference in the probabilities that black patients would use a high-quality (or a low-quality) hospital in the hypothetical scenario where they face white patients' choice sets versus when they face their own choice sets. We conceptualize the second component as the difference in the probabilities that white patients and black patients would use a high-quality (or a low-quality) hospital if they both faced white patients' choice sets. In this Appendix, we provide details on how we operationalize these concepts to decompose the overall white-black gap in high-quality hospital use. The decomposition of the overall gap in low-quality hospital is exactly analogous.

We index patients using the subscript i and use W to denote the set of white patients and B to denote the set of black patients. Thus $i \epsilon W$ means that patient i is white and $i \epsilon B$ means that patient i is black. We denote the total numbers of white and black patients by N_w and N_b, respectively. We use S_i to denote patient i's "choice set" of hospitals and note that S_i is composed of a subset of high-quality hospitals, which we denote as H_i; a subset of medium-quality hospitals, M_i; and a subset of low-quality hospitals, L_i. In set notation, we can write: $S_i = H_i \cup M_i \cup L_i$.

As described in the Methods section, we estimated conditional logit models that modeled the probability that a patient uses a particular hospital as a function of the quality of all the hospitals in the patient's choice set (indicator variables for high, medium, and low) and the home-to-hospital distance for all the hospitals in the choice set. Because the distance from a patient's home to the closest hospital varies across patients and because the relationship between distance and hospital choice is nonlinear, we specified distance using a binary indicator variable for the closest hospital in each patient's choice set and a set of indicator variables for incremental distance categories (0--2, 2-4, 4-6, 6-8, 8-10, 10-15, 15-30, 30-60 and >60). We denote the vector of attributes (i.e., the indicators for quality and distance) for hospital h, as they pertain to patient i, as $X_{i,h}$. As mentioned in the paper, when we estimated the models we interacted patient race with the hospital attributes. Thus we effectively estimated distinct vectors of regression coefficients for white and black patients, which we denote as $\hat{\beta}_w$ and $\hat{\beta}_b$, respectively.

According to a standard formula for conditional logit models,[1] the predicted probability, $\hat{p}_{i,h}$, that white patient i uses hospital h in her choice set is given by:

$$\hat{p}_{i,h} = \frac{exp\ (\hat{\beta}_w X_{i,h})}{\sum_{k \epsilon S_i} exp\ (\hat{\beta}_w X_{i,k})}$$

for $i \epsilon W$. To obtain the predicted probability that patient i uses a high-quality hospital, $\hat{P}_i(High)$, we sum the predicted probabilities, $\hat{p}_{i,h}$, across the high-quality hospitals in patient i's choice set. Therefore, we can write:

$$\hat{P}_i(High) = \sum_{h \epsilon H_i} \hat{p}_{i,h}$$

for $i \epsilon W$.

Finally, to obtain the predicted probability that white patients use a high-quality hospital when they face white patients' choice sets (i.e., their own choice sets), $\hat{P}_w(High|white\ choice\ sets)$, we average $\hat{P}_i(High)$ across all the white patients in the study:

$$\hat{P}_w(High|white\ choice\ sets) = \frac{\sum_{i \epsilon W} \hat{P}_i(High)}{N_w}$$

This is the first quantity we need for our decomposition.

Using analogous reasoning, the predicted probability, $\hat{p}_{i,h}$, that black patient *i* uses hospital *h* in her choice set is given by:

$$\hat{p}_{i,h} = \frac{exp\ (\hat{\beta}_b X_{i,h})}{\sum_{k \epsilon S_i} exp\ (\hat{\beta}_b X_{i,k})}$$

for $i \epsilon B$. To obtain the predicted probability that patient *i* uses a high-quality hospital, $\hat{P}_i(High)$, we sum the predicted probabilities, $\hat{p}_{i,h}$, across the high-quality hospitals in patient *i*'s choice set, as follows:

$$\hat{P}_i(High) = \sum_{h \epsilon H_i} \hat{p}_{i,h}$$

for $i \epsilon B$.

Finally, to obtain the predicted probability that black patients use a high-quality hospital when they face black patients' choice sets (i.e., their own choice sets), $\hat{P}_b(High|black\ choice\ sets)$, we average $\hat{P}_i(High)$ across all the black patients in the study:

$$\hat{P}_b(High|black\ choice\ sets) = \frac{\sum_{i \epsilon B} \hat{P}_i(High)}{N_b}$$

This is the second quantity we need for our decomposition.

The third quantity we need for our decomposition is the predicted probability that black patients use a high-quality hospital when they face white patients' choice sets rather than their own choice sets. This is the trickiest quantity to obtain, because it requires taking the white patients, each of which comes with her own choice set, and assigning the probabilities of using each hospital in a choice set as if the patient were black rather than white. (This is what it means for black patients to face white patients' choice sets.) In practice, this is accomplished by calculating the predicted probabilities, $\hat{p}_{i,h}$, using white patients' choice sets, but using the black coefficients, $\hat{\beta}_b$, in place of the white coefficients. Thus we calculate:

$$\hat{p}_{i,h}^* = \frac{exp\ (\hat{\beta}_b X_{i,h})}{\sum_{k \epsilon S_i} exp\ (\hat{\beta}_b X_{i,k})}$$

for $i \epsilon W$. The fact we sum over the choice sets for $i \epsilon W$ is the key that indicates we are using white patients' choice sets. We also modify the notation, adding an asterisk superscript to $\hat{p}_{i,h}^*$ in order to denote that these are predicted probabilities for black patients facing white choice sets.

To obtain the predicted probability that black patient *i* uses a high-quality hospital, $\hat{P}_i^*(High)$, we sum the predicted probabilities, $\hat{p}_{i,h}^*$, across the high-quality hospitals in the choice set, as follows:

$$\hat{P}_i^*(High) = \sum_{h \epsilon H_i} \hat{p}_{i,h}^*$$

for $i \epsilon W$.

Finally, to obtain the predicted probability that black patients use a high-quality hospital when they face white patients' choice sets, $\hat{P}_b^*(High|white\ choice\ sets)$, we average $\hat{P}_i^*(High)$ across all the white choice sets in the study:

$$\hat{P}_b^*(High|white\ choice\ sets) = \frac{\sum_{i \epsilon W} \hat{P}_i^*(High)}{N_w}$$

This is the third quantity we need for our decomposition.

Now we are ready to decompose the overall white-black gap in high-quality hospital use, $\Delta(white - black)$. As we have defined it, the overall gap is the difference between the probability that white patients use a high-quality hospital and the probability that black patients use a high-quality hospital when each race faces its own choice sets. Thus we can write:

$$\Delta(white - black) = \hat{P}_w(High|white\ choice\ sets) - \hat{P}_b(High|black\ choice\ sets)$$

Adding and subtracting the quantity $\hat{P}_b^*(High|white\ choice\ sets)$ and rearranging terms, we obtain:

$$\Delta(white - black) = \{\hat{P}_b^*(High|white\ choice\ sets) - \hat{P}_b(High|black\ choice\ sets)\}$$
$$+ \{\hat{P}_w(High|white\ choice\ sets) - \hat{P}_b^*(High|white\ choice\ sets)\}$$

As desired, the first term on the right side of this equation captures the racial differences in geographic access to high-quality hospitals, whereas the second term captures the racial differences in hospital choice behavior. For both components positive values favor whites, that is, positive values indicate that white patients are more likely than blacks to use high-quality hospitals.

1.   McFadden D. Conditional logit analysis of qualitative choice behavior. In: Zaremba P, ed. *Frontiers in Econometrics.* New York: Academic Press; 1973:105-142.

Table S1. Characteristics of hospitals treating black and white Medicare beneficiaries admitted with AMI or undergoing CABG during 2009-2011.

Characteristic	AMI (N=2,570)	CABG (N=1,006)
Quality		
% High Quality	21.3%	27.7%
% Medium Quality	59.6%	56.6%
% Low quality	19.0%	15.7%
Revascularization services		
PCI and CABG	44.5%	N/A
PCI only	25.4%	N/A
None	30.0%	N/A
Teaching status		
Major	10.1%	20.8%
Minor	21.1%	28.7%
None	68.3%	49.9%
Ownership		
For-profit	17.7%	17.9%
Private not-for-profit	67.3%	69.7%
Government non-federal	14.4%	11.8%
Bed size		
<100	21.3%	2.1%
100-299	49.3%	42.1%
300-499	18.8%	32.6%
≥ 500	10.1%	22.6%

Table S2. Model coefficients, standard errors and statistical significance.

Model variables[†]	AMI		CABG	
	Estimate	Robust SE	Estimate	Robust SE
White*high quality hospital	0.79*	0.079	0.68*	0.14
White*medium quality hospital	0.34*	0.076	0.11	0.12
Black*high quality hospital	0.42*	0.083	0.35***	0.18
Black*medium quality hospital	0.19***	0.088	0.29	0.18
White*0-2 miles	-0.18*	0.048	-0.06	0.08
White*2-4 miles	-0.77*	0.062	-0.41*	0.07
White*4-6 miles	-1.28*	0.087	-0.77*	0.11
White*6-8 miles	-1.72*	0.127	-1.07*	0.11
White*8-10 miles	-2.26*	0.127	-1.36*	0.12
White*10-15 miles	-2.97*	0.142	-2.01*	0.12
White*15-30 miles	-4.19*	0.138	-3.01*	0.15
White*30-60 miles	-5.97*	0.128	-4.33*	0.15
White*60-100 miles	-7.86*	0.086	-6.08*	0.16
Black*0-2 miles	-0.20***	0.100	-0.02	0.14
Black *2-4 miles	-0.92*	0.097	-0.35**	0.13
Black *4-6 miles	-1.44*	0.140	-0.74*	0.16
Black *6-8 miles	-1.88*	0.193	-1.00*	0.14
Black *8-10 miles	-2.51*	0.199	-1.29*	0.11
Black *10-15 miles	-3.18*	0.224	-2.24*	0.17
Black *15-30 miles	-4.61*	0.194	-3.22*	0.24
Black *30-60 miles	-6.14*	0.147	-4.63*	0.19
Black *60-100 miles	-7.97*	0.131	-5.81*	0.29

[†]Omitted (reference) categories were white*low quality hospital and black*low quality hospital for quality, and white*closest hospital and black*closest hospital for distance categories

*p<.001; **p<.01; ***p<.05

Figure S1.

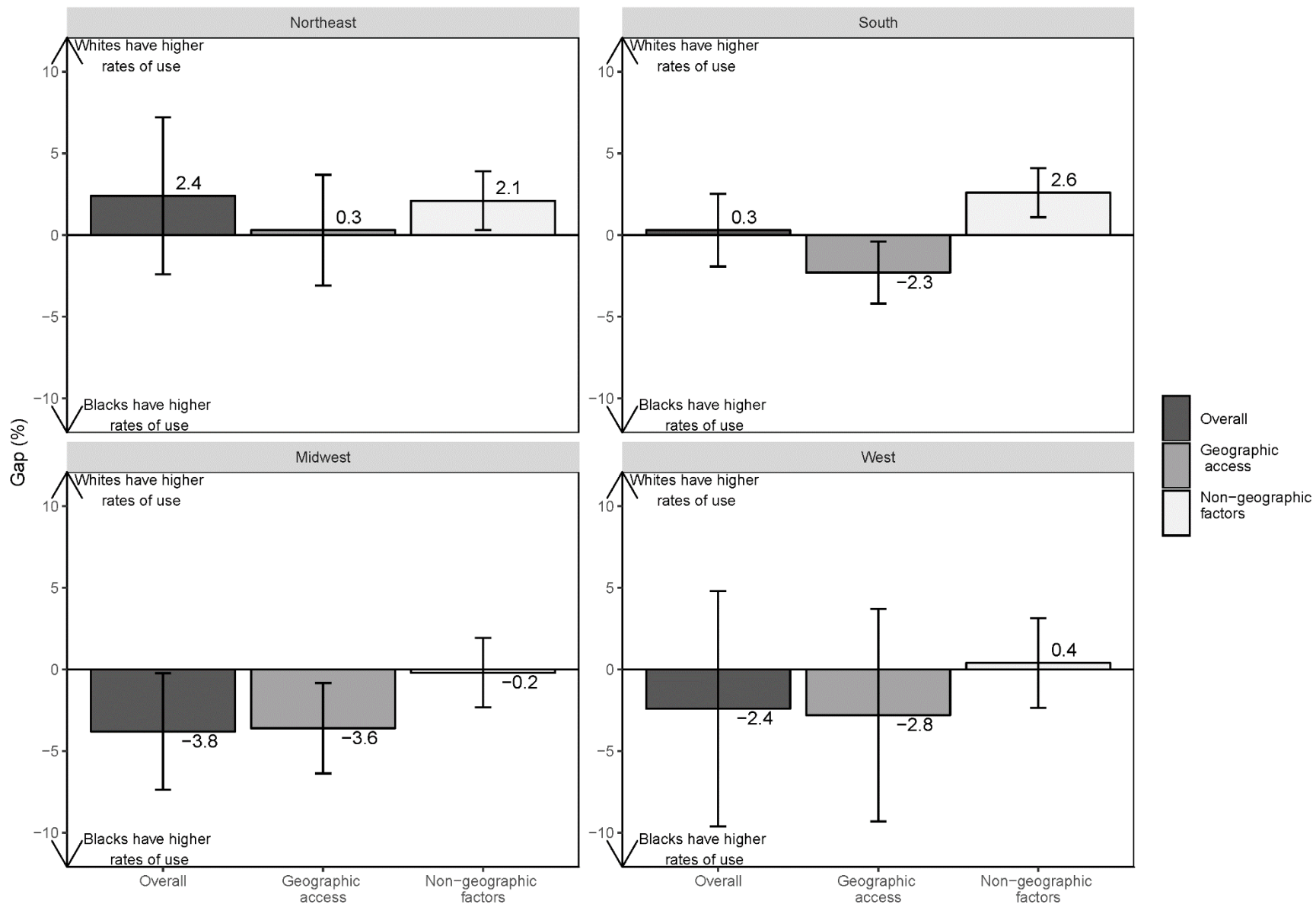Regional white–black gaps in low-quality hospital use for AMI

Figure S2.

Regional white−black gaps in low−quality hospital use for CABG