Original Article

Improving economic conditions associated with care pattern and cost changes

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Abstract

Background: Low economic prosperity is associated with worse health and health outcomes. Dramatic increases in prosperity have been associated with reductions in mortality rates.

Methods: We conducted a retrospective serial cross-sectional study of Medicare beneficiaries aged 65 and older who were enrolled in Medicare Parts A and B each year, 2003–2015. We examined local economic conditions in 2000 and 2015 at the Dartmouth Atlas-defined Hospital Service Area level. For quintiles of local economic distress in 2000, and for areas that experienced dramatic improvement or deterioration in local economic distress, we calculated per-capita rates of avoidable admissions, receipt of appropriate primary care services, elective surgery utilization, and total Medicare Parts A and B healthcare spending

Results: Beneficiaries who lived in the lowest-prosperity areas had higher rates of avoidable admissions, lower rates of appropriate primary care services, higher rates of elective surgeries, and higher overall healthcare spending than those living in the highest-prosperity areas. Dramatic improvement in local economic conditions was associated with adoption of healthcare utilization closely resembling those of the most-prosperous areas and divergent from that of areas that did not see improvement; further, the most-prosperous areas had healthcare consumption patterns that were "immune" to economic decline.

Conclusions: Our findings suggest that improving local economic conditions could have healthcare utilization and quality implications. Policymakers should consider improved healthcare quality and reduced avoidable and potentially unnecessary high-cost care as potential returns on investment in improving local economic conditions, while being mindful of potential increases in care costs.

Keywords: Fee-for-Service Plans; Health Care Costs; Medicare; Quality of Health Care; Social Determinants of Health.

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Introduction

Initiated in 1967, Britain's Whitehall Study examined the epidemiology of cardiorespiratory disease and diabetes in 18,403 male civil servants aged 40–64 years old (1). It found that working in a lower "employment grade" was associated with a higher prevalence of cardiovascular mortality-related risk factors and, importantly, substantially higher mortality rates after adjusting for those mortality-related risk factors (2). The study's findings raised the possibility that economic prosperity might influence health.

Since then, prosperity has been acknowledged as an important determinant of health in low- and middle-income countries (3), Canada (4), the United States (5,6), and the world (7).

While those studies examined broad populations, there is a growing body of evidence that such relationships affect Medicare fee-for-service beneficiaries, for whom lower economic prosperity is associated with worse care quality (8), higher mortality rates and per-capita healthcare expenditures (9), and higher end-of-life costs (10). There is some evidence that improvements in local economic conditions are associated with better health outcomes: in the older fee-for-service Medicare population between 2000–2015, substantial improvement in local economic prosperity from the worst conditions was associated with a rapid and dramatic reduction in age-, sex-, and race-adjusted mortality rates and higher per-capita costs (11).

To investigate potential underlying causes of such dramatic and rapid improvements in mortality rates, we explored whether health services utilization, healthcare quality measures, and healthcare costs were associated with the degree and direction of change in local economic prosperity between 2000–2015 in the older Medicare fee-for-service population.

Methods

We used an observational, retrospective serial cross-sectional analysis to examine changes in health services utilization, quality, and per-capita healthcare spending in HSAs where local economic conditions did or did not change dramatically between 2000 – 2015.

From the Dartmouth Atlas Project, for Medicare fee-for-service enrollees, we obtained 2003–2015 hospital service area (HSA) level data on ambulatory care sensitive condition (ACSC) and total medical admissions rates, primary care service usage, elective surgery admissions rates, and price-, age-, sex-, and race- (PASR) adjusted annual per-capita total Medicare Parts A and B expenditures and, expenditures on 5 care components: inpatient, outpatient, physician, home health, and durable medical equipment.

From the Economic Innovation Group (EIG), we obtained 2000 and 2015 ZIP Code level Distressed Communities Index (DCI) scores, which are constructed from 7 measures of local economic distress and range from 0 (most prosperous) to 100 (least prosperous) (8-11). Using previously described methods (11), we computed enrollee-weighted HSA-level scores and used them to assign 3,212 HSAs to DCI-based prosperity quintiles for 2000.

We identified HSAs that were in the highest or lowest prosperity quintiles in 2000 and compared medical admissions rates, primary care service usage, elective surgeries, and fee-for-service expenditures for HSAs in which local economic prosperity either: declined or improved by at least two quintiles by 2015 (n=14 and 39, respectively; details on these HSAs' locations and fee-for-service populations in 2000 and 2015 are provided in the **Appendix**); declined or improved by one quintile by 2015 (n=127 and 122, respectively); or remained in the highest or lowest quintile in 2015 (n=501 and 481, respectively).

For each metric whose ANOVA gave a statistically significant result, we examined three pairwise comparisons: (a) between HSAs that started in the highest prosperity quintile in 2000 and either saw a dramatic decline in economic conditions or remained in the same quintile in 2015 ("started prosperous and got worse" v. "started and stayed prosperous"; a non-significant difference in all years is taken to be evidence of "high-prosperity clustering"); (b) between HSAs that started in the lowest prosperity quintile in 2000 and either saw a dramatic improvement in economic conditions or remained in the same quintile in 2015 ("started unprosperous and got better" v. "started and stayed unprosperous"; a significant difference in at least 2015 is taken to be evidence of "low-prosperity splintering"); and (c) between HSAs that started in the lowest prosperity quintile in 2000 and saw dramatic improvement in economic conditions by 2015, and HSAs that started in the highest prosperity quintile in 2000 and remained there in 2015 (comparing "started unprosperous and got better" to "started and stayed prosperous": a non-significant difference in at least 2015 is taken to be evidence of "upward mobility").

High-prosperity clustering, low-prosperity splintering, and upward mobility are evidenced, respectively: when HSAs that were the most prosperous in 2000 had the same utilization patterns in all years, regardless of whether local economic conditions deteriorated or stayed the same by 2015; when HSAs that saw dramatic increases in prosperity from the worst initial conditions came to have significantly different utilization patterns compared to HSAs that started and stayed in the worst economic conditions; and when HSAs that saw dramatic improvement in economic conditions between 2000 and 2015 adopted statistically equivalent healthcare consumption patterns to those of the most-prosperous HSAs. Together, evidence for both low-prosperity splintering and upward mobility demonstrates a particular profile for the relationship between economic change and healthcare utilization, where increases in economic prosperity are associated with significant changes in healthcare usage patterns—away from those of the least-prosperous HSAs and toward those of the most-prosperous. Evidence for all three phenomena demonstrates a subtype of that profile, where—in addition to the features described above—healthcare utilization patterns of the most-prosperous HSAs appear to be "immune" to economic decline.

To evaluate differences between prosperity-change cohorts, we used enrollee-weighted Welch's ANOVA and, where appropriate, enrollee-weighted post-hoc Welch's unequal variance *t*-tests (R, Vienna Austria) to compare care metrics between prosperity quintiles in each year. To account for the error introduced by multiple comparisons, ANOVA *p*-values for each year were Bonferroni-corrected. Similarly, for each metric, post-hoc *p*-values for the three pairwise (by prosperity-change cohort) comparisons of interest for each year were Bonferroni-corrected as an ensemble over all years. Since post-hoc *p*-values are derived from the *t*- (rather than the *F*-) distribution, they were Bonferroni-corrected separately from the ANOVA *p*-values.

Data were not available for all admissions metrics in all HSAs in all years; the completeness of data for a given metric in a given prosperity cohort is reflected in the average number of HSAs included ("*n*=" for each figure panel), as compared to the total number of HSAs in that prosperity cohort ("*n*=" at the top of each figure). In order to ensure the representativeness of our results, we limited the analysis to care metrics for which at least 50% of HSAs had data in each prosperity-change cohort, in each year. Finally, to determine whether our findings might be associated with changes in populations in areas with dramatic changes in local economic conditions, we report the number of Medicare fee-for-service enrollees in those HSAs in 2000 and 2015.

As all data were obtained from publicly available sources, IRB approval was not required.

Results

Per-capita rates of total ACSC admissions, admissions for each ACSC subtype, and total medical admissions decreased over time but were invariably highest in areas where prosperity started and remained low and lowest in areas where prosperity started and remained high (**Figure 1**). Rates of each category of admission varied according to prosperity-change cohort (p<0.0001 in all years, ANOVA). Among HSAs experiencing the highest prosperity in 2000, rates of each kind of admission were statistically no different between HSAs that continued to be highly prosperous in 2015 and those that became unprosperous by 2015 (comparing "started prosperous and got worse" to "started and stayed prosperous": p>0.05 in all years for each type of admission; "clustering"). Among HSAs that were least prosperous in 2000, rates of each kind of admission (except for kidney/urinary infections) were significantly lower in HSAs that saw dramatic increases in prosperity by 2015, compared to those that continued to be unprosperous in 2015 (comparing "started unprosperous and got better" to "started and stayed unprosperous": bacterial pneumonia, congestive heart failure, total ACSC admissions, and total medical admissions: p<0.001 in all years; admission for COPD: p<0.05 in all years; "splintering"; [kidney/urinary infections: p>0.05 in all years except 2008–10]). Moreover, initially unprosperous HSAs that experienced dramatic increases in prosperity by 2015 had admissions rates (except for total ACSC admissions and total medical admissions) that increasingly resembled those of initially prosperous HSAs that remained so (comparing "started unprosperous and got better" to "started and stayed prosperous": bacterial pneumonia: p>0.05 in 2008–15; congestive heart failure: p>0.05 in 2013–15; COPD: p>0.05 in 2004–15; kidney/urinary infections: p>0.05 in 2015; "upward mobility"; [total ACSC admissions: p<0.05 in all years; total medical admissions: p<0.0001 in all years]).

Rates of eye exam for diabetics age 65–75 and ambulatory visits to primary care physicians (by all enrollees) remained static over time, while rates of recommended blood tests for diabetics age 65–75 (A1c and LDL-C) increased (**Figure 2**). In general, diabetic enrollees age 65–75 in the least-prosperous HSAs in 2000 were less likely to receive recommended primary care services (eye exam and A1c and LDL-C blood tests) in all years, compared to those in the most-prosperous HSAs in 2000; rates of ambulatory visits did not show any such trend. Rates of each primary care service varied according to prosperity-change cohort (p<0.0001 in all years, ANOVA). Enrollees living in HSAs that experienced a dramatic decline in economic prosperity between 2000 and 2015 had significantly higher rates of ambulatory visits to primary care physicians compared to enrollees living in HSAs that remained in the highest prosperity quintile (comparing "started prosperous and got worse" to "started and stayed prosperous": p<0.05 in 2008–11; no "clustering"). Enrollees living in HSAs that experienced dramatic improvement in economic conditions between 2000 and 2015 had significantly lower rates of ambulatory visits to primary care physicians compared to enrollees living in the least-prosperous HSAs (comparing "started unprosperous and got better" to "started and stayed unprosperous": p<0.0001 in all years; "splintering"). Among diabetics, rates of eye exam and recommended blood testing were higher for those living in highly prosperous areas than for those living in unprosperous areas; however, dramatic changes in prosperity from either initial extreme were not associated with persistent changes in rates of eye exam or recommended blood testing (comparing "started prosperous and got worse" to "started and stayed prosperous":

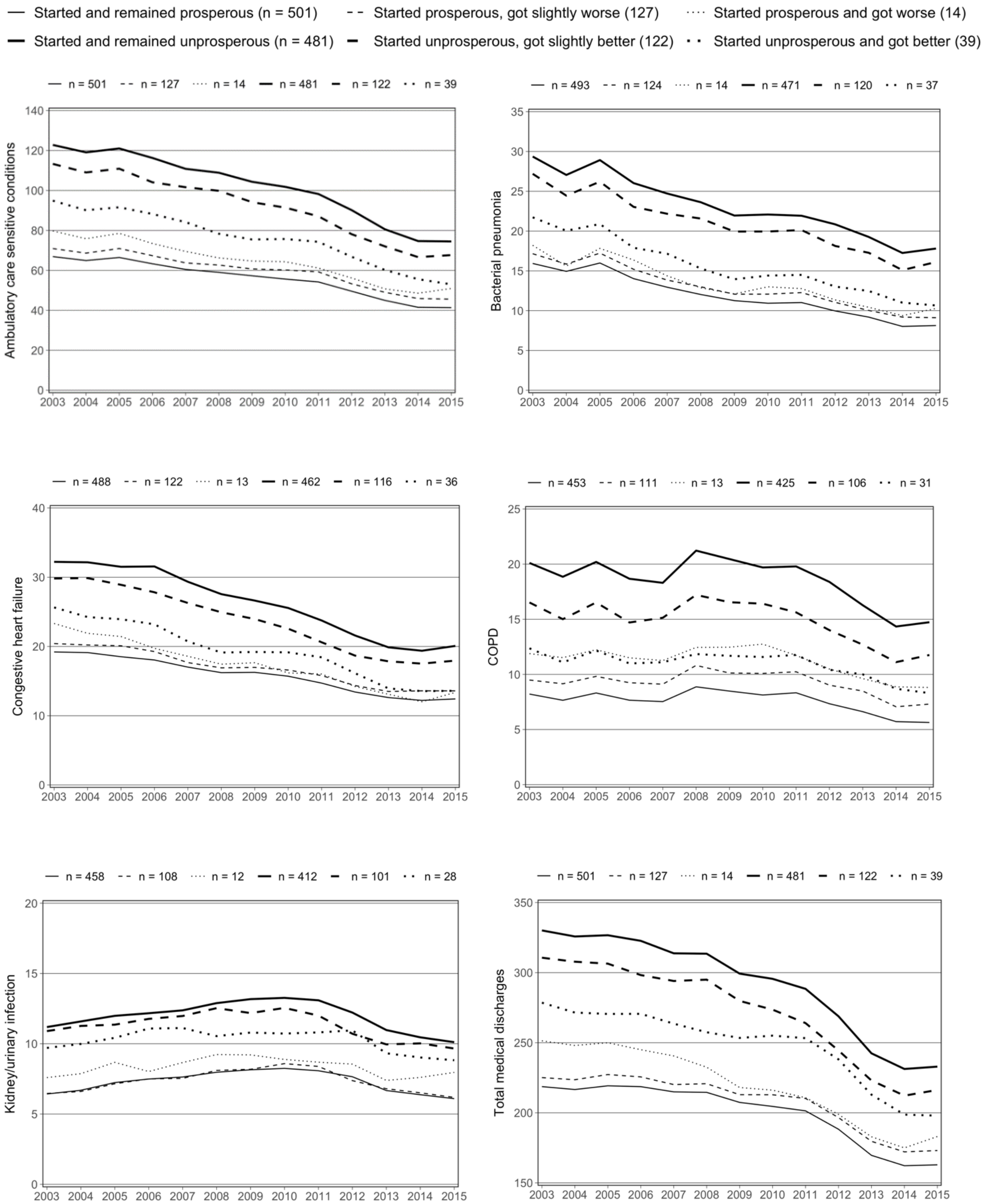

Figure 1. Total avoidable medical admissions, 4 subtypes thereof, and total medical admissions per 1,000 Medicare enrollees by distress cohort. Aggregated admissions weighted by Medicare enrollment in the HSA.

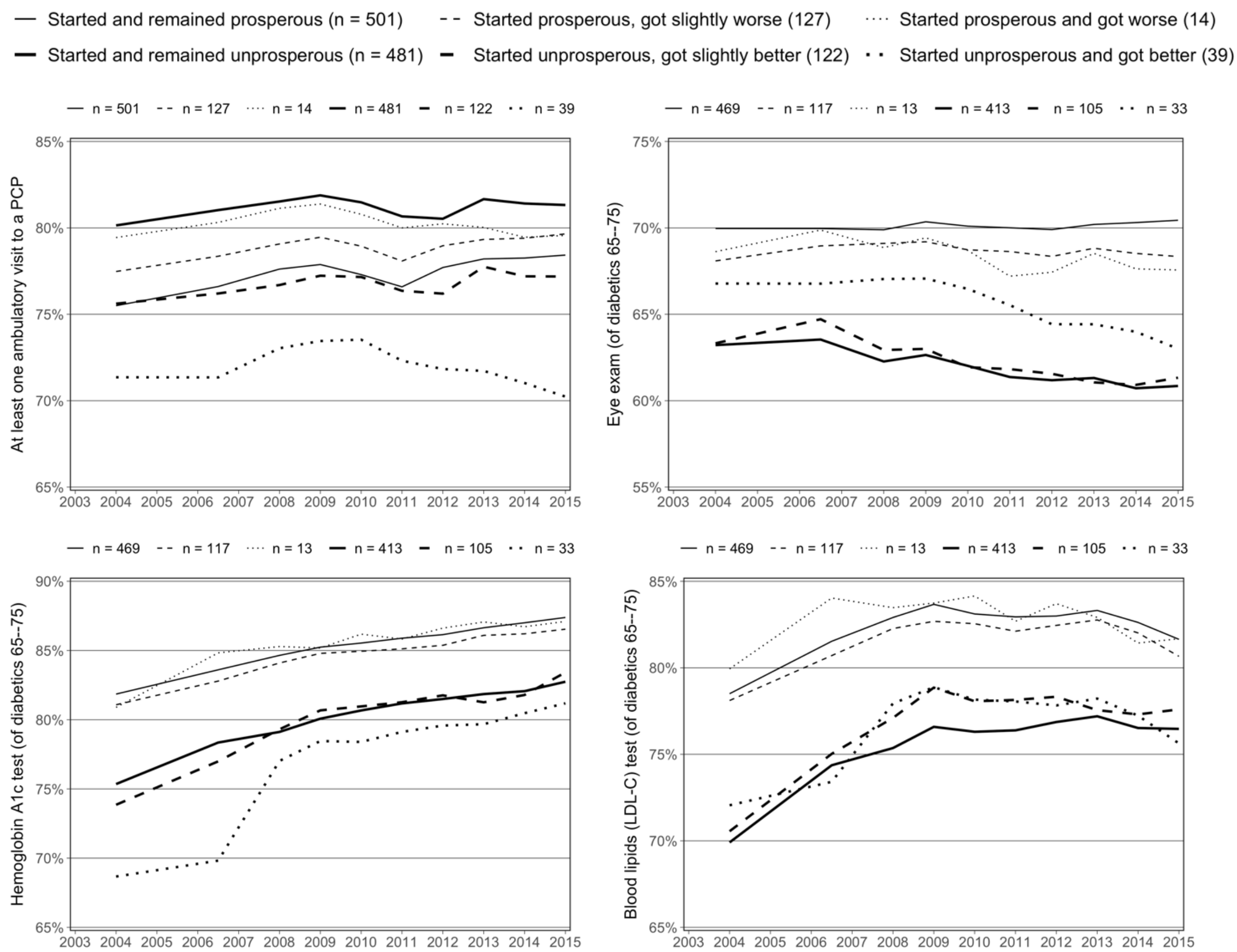

Figure 2. Utilization of recommended primary care services. Data spanning 2003–2005 were used to generate points plotted in 2004; data spanning 2006–2007 are plotted at 2006.5. HSA-level data for percent of enrollees having at least 1 ambulatory visit to a primary care physician were aggregating using Medicare Part B enrollment figures as weights.

eye exam, A1c test, and LDL-C test: p>0.05 in all years; "clustering"; comparing "started unprosperous and got better" to "started and stayed unprosperous": eye exam: p>0.05 in 2013–15; A1c test: p>0.05 for 2008–15; LDL-C test: p>0.05 in all years; no "splintering"). For all primary care metrics, rates in HSAs that experienced dramatic improvement in economic conditions did not statistically come to resemble those of persistently highly-prosperous HSAs (comparing "started unprosperous and got better" to "started and stayed prosperous": ambulatory visits: p<0.05 in all years except 2010; eye exam: p<0.05 in all years except 2008; A1c test: p<0.0001 in all years; LDL-C test: p<0.001 in all years; no "upward mobility"); however, rates of ambulatory visits in HSAs that saw dramatic improvement in economic conditions were even lower than those in HSAs that started and stayed prosperous (i.e., rates for "started unprosperous and got better" were below those for "started and stayed prosperous," which were below those for "started and stayed unprosperous"; **Figure 2**), demonstrating an extreme degree of "upward mobility."

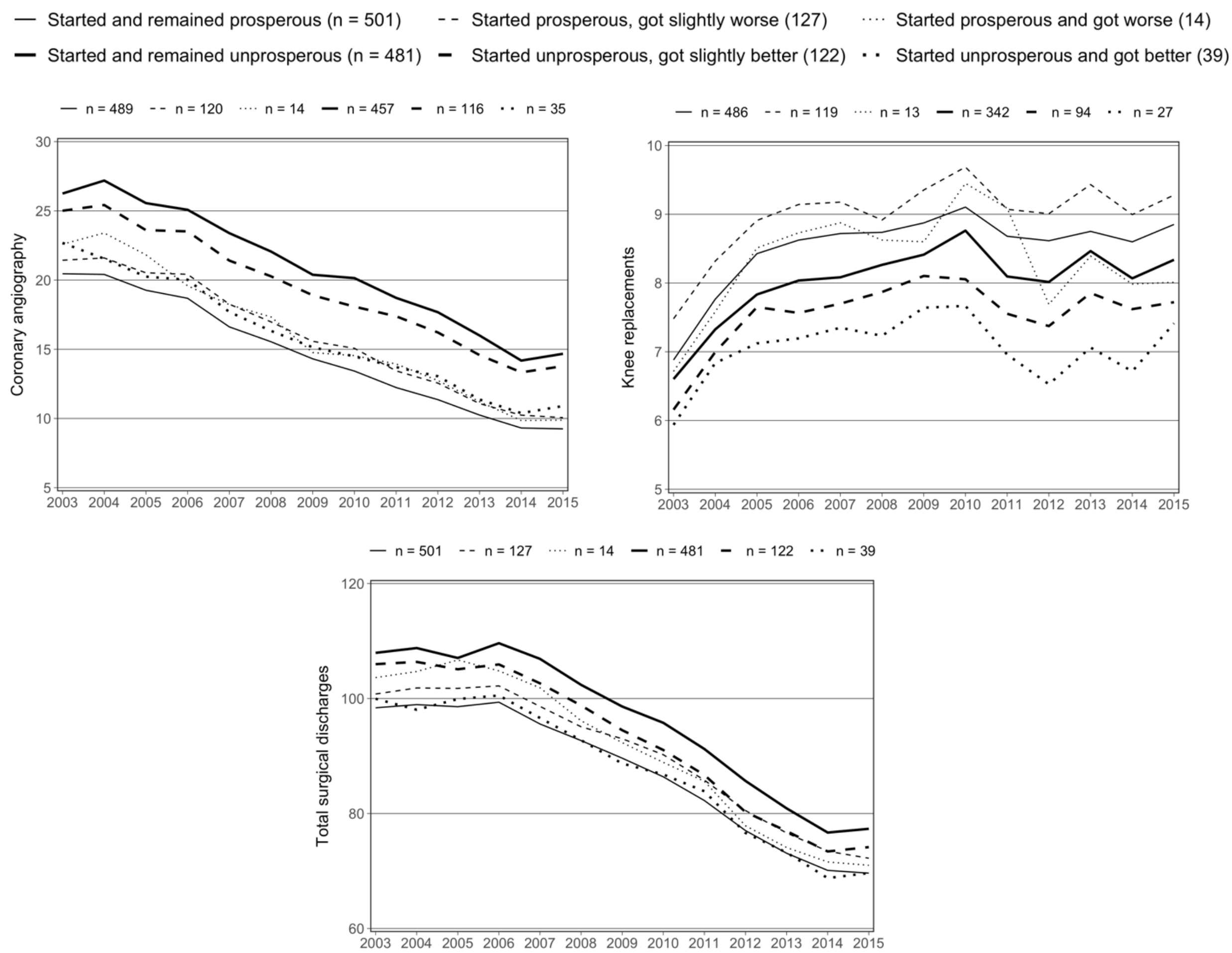

Figure 3. Elective surgeries per 1,000 Medicare enrollees. Aggregated surgeries figures weighted by per-HSA Medicare enrollment.

Though rates of coronary angiography and total elective surgeries decreased over time, they were higher for enrollees living in the least-prosperous HSAs in 2000 than for those living in the most-prosperous HSAs in 2000 (**Figure 3**). Rates of knee replacement did not consistently vary according to prosperity-change cohort (p>0.05 in 6 of 13 years, ANOVA), but rates of coronary angiography and total elective surgeries did vary according to prosperity-change cohort (p<0.0001 in all years, ANOVA). For coronary angiography and total elective surgeries, rates were statistically comparable between HSAs that experienced a dramatic decline in prosperity between 2000 and 2015 and those that started and remained prosperous (comparing "started prosperous and got worse" to "started and stayed prosperous": coronary angiography and total elective surgeries: p>0.05 in all years; "clustering"). The least-prosperous HSAs in 2000 saw diverging rates as a function of their prosperity in 2015: total rates of elective surgery and rates of coronary angiography were lower, by an increasing margin, in the "started unprosperous and got better" cohort than in the "started and stayed unprosperous" cohort (coronary angiography: p>0.05 in 2003, p<0.01 in 2004, p<0.001 in 2005–6, p<0.0001 in 2007–15; total elective surgeries: p>0.05 in 2005, p<0.01 in 2006–8, p<0.001 in 2009–15; "splintering"). Moreover, HSAs that saw dramatic improvement in prosperity had per-capita utilization that was statistically comparable to that in HSAs that

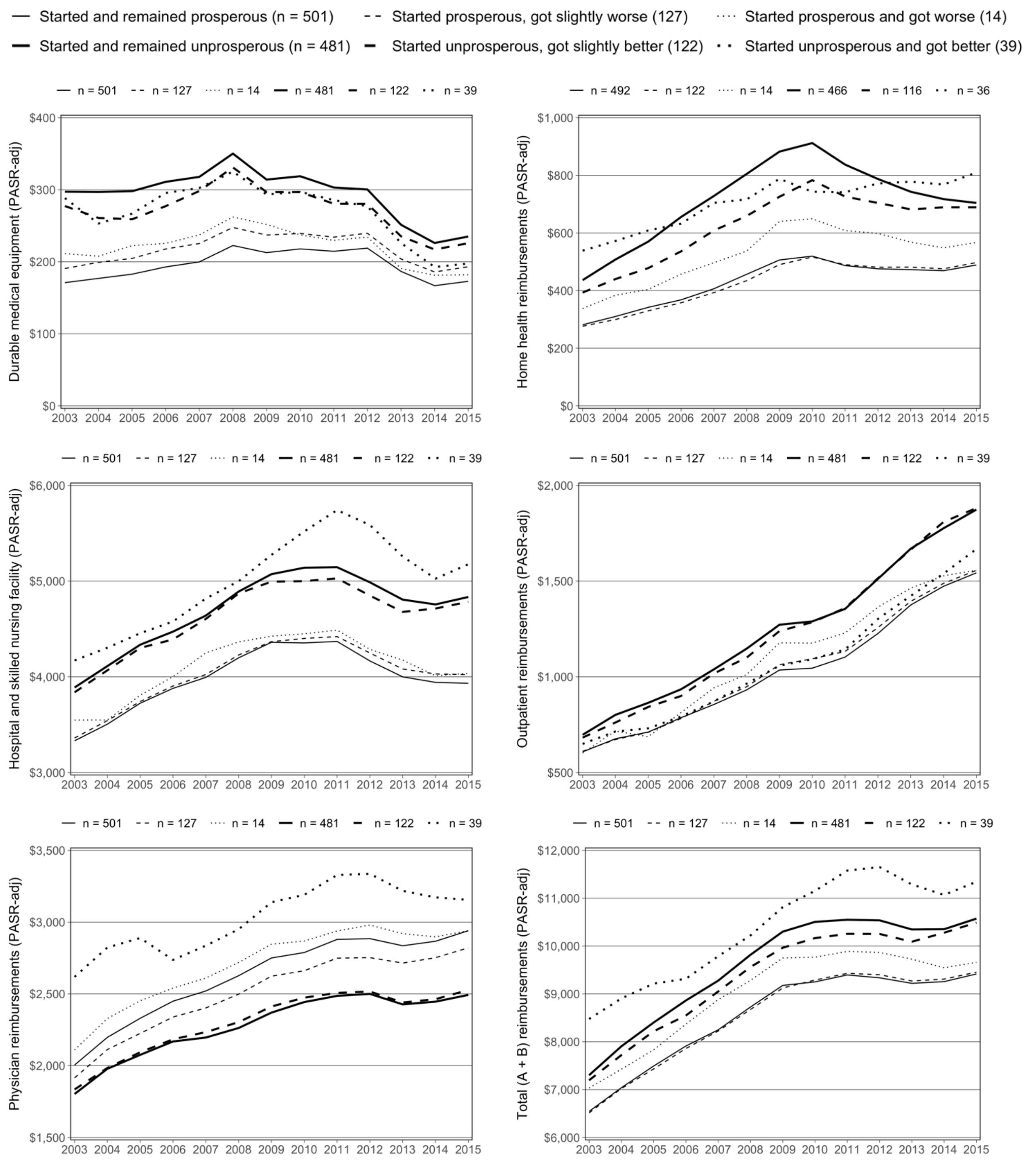

Figure 4. Medicare FFS spending (price-, age-, sex-, and race- (PASR) adjusted) per enrollee.

started and stayed prosperous (comparing "started unprosperous and got better" to "started and stayed prosperous": $p>0.05$ in all years; "upward mobility").

With the exception of spending on durable medical equipment, per-capita spending increased over time (**Figure 4**). Except for physician reimbursements (which showed the opposite trend), per-capita spending was higher in HSAs that were least-prosperous in 2000, compared to those that were most-prosperous in 2000; for outpatient, home health, and durable medical equipment spending, those living in the least- or most-prosperous HSAs that improved or declined, respectively, generally fell between the extremes. Rates of each category of fee-for-service spending varied according to prosperity-change cohort (p<0.0001 in all years, ANOVA). Each kind of spending was statistically comparable between HSAs that experienced a dramatic decline in economic conditions between 2000 and 2015 and those that remained in the highest prosperity quintile (comparing "started prosperous and got worse" to "started and stayed prosperous": p>0.05 in all years; "clustering"). For durable medical equipment and physician fee-for-service spending (but not for the other spending categories), those living in HSAs that experienced dramatic increases in prosperity had significantly different per-capita spending levels (lower for durable medical equipment; higher for physician spending) than those living in HSAs that started and remained unprosperous (comparing "started unprosperous and got better" to "started and stayed unprosperous": durable medical equipment: p<0.05 in 2012, p<0.001 in 2013–15; physician: p<0.01 in all years; "splintering"; [home health: p>0.05 in all years; hospital and skilled nursing facility: p>0.05 in all years except 2011–12; outpatient: p>0.05 in 2003–4, 2015; total spending: p>0.05 in 2005–10 and 2014–15]). Finally, in HSAs where prosperity

Table 1. Summary of the interpretation of statistical test results (Bonferroni-corrected p values).

Care metric	ANOVA	High-prosperity clustering	Low-prosperity splintering	Upward mobility
Ambulatory care sensitive conditions	X	X	X	.
Bacterial pneumonia*	X	X	X	X
Congestive heart failure*	X	X	X	X
COPD*	X	X	X	X
Kidney/urinary infection	X	X	.	X
Total medical admissions	X	X	X	.
Ambulatory visits	X	.	X	X
Eye exam (for diabetics 65–75)	X	X	.	.
A1c test (for diabetics 65–75)	X	X	.	.
LDL-C test (for diabetics 65–75)	X	X	.	.
Coronary angiography*	X	X	X	X
Knee replacement	.	—	—	—
Total elective surgeries*	X	X	X	X
Durable medical equipment	X	X	X	.
Home health	X	X	.	.
Hospital and skilled nursing facility	X	X	.	.
Outpatient	X	X	.	X
Physician*	X	X	X	X
Total expenditures	X	X	.	.

ANOVA: the metric varies according to prosperity-change cohort (p<0.05 in all years). High-prosperity clustering: HSAs that were most prosperous in 2000 are statistically comparable, no matter their prosperity cohort in 2015 (comparing "started prosperous and got worse" to "started and stayed prosperous," p>0.05 in all years). Low-prosperity splintering: among HSAs that were least prosperous in 2000, those that saw dramatic improvement in economic conditions are statistically different from those that remained the least prosperous in 2015 (comparing "started unprosperous and got better" to "started and stayed unprosperous," p<0.05 in at least 2015). Upward mobility: HSAs that saw dramatic increases in prosperity by 2015 from the worst initial conditions in 2000 are statistically comparable to those that started and stayed the most prosperous (comparing "started unprosperous and got better" to "started and stayed prosperous": p>0.05 in at least 2015; except for ambulatory visits, cf. Results). For each metric, each condition is either satisfied (X), unsatisfied (.), or not applicable because ANOVA is not significant in all years (—). The six-care metrics that satisfy all four conditions are printed before an asterisk.

improved dramatically, outpatient and physician fee-for-service spending (but not the other spending categories) came to statistically resemble spending in HSAs that started and remained prosperous (comparing "started unprosperous and got better" to "started and stayed prosperous": outpatient: $p>0.05$ in all years; physician: $p>0.05$ in 2006–15; "upward mobility"; [durable medical equipment: $p<0.0001$ in all years; home health: $p<0.01$ in all years; hospital and skilled nursing facility: $p<0.001$ in all years; total spending: $p<0.0001$ in all years]).

The results of these statistical comparisons are summarized in Table 1.

The 2015 to 2000 ratio of Medicare fee-for-service enrollees in the 39 HSAs which were the least prosperous in 2000 but improved by at least two prosperity quintiles by 2015 was 0.71 (95% CI: 0.68–0.74); that for the 14 HSAs which were the most prosperous in 2000 but declined by at least two prosperity quintiles by 2015 was 0.78 (95% CI: 0.61–0.95) and did not statistically differ from those HSAs that improved (**Supplemental table**).

Discussion

Using publicly available Medicare fee-for-service data, we explored the relationship of per-capita avoidable medical admissions rates, primary care service utilization rates, elective surgery rates, and expenditures across a variety of spending categories with changes in local economic prosperity between 2000–2015. In nearly every measure examined, we found that beneficiaries who lived in the least-prosperous areas experienced higher overall healthcare spending, with higher rates of elective surgeries and avoidable admissions and lower rates of appropriate primary care services.

For all care metrics except one (knee replacement), healthcare consumption patterns consistently varied according to prosperity-change cohort. Low-prosperity splintering was demonstrated for all avoidable medical admissions except those for kidney/urinary infection and by both elective surgeries for which ANOVA was significant. By contrast, low-prosperity splintering was largely not demonstrated for primary care metrics or reimbursements, with only ambulatory visits (and no measures related to diabetic care), durable medical equipment spending, and physician reimbursements fitting the profile for splintering. Similarly, avoidable medical admissions (excepting ambulatory care sensitive conditions and total medical admissions) largely fit the profile for upward mobility, as did both elective surgeries for which ANOVA was significant. By contrast, only two spending measures (outpatient and physician) and one primary care measure (ambulatory visits) showed evidence for upward mobility.

Of note, among the 18 metrics for which consumption patterns varied according to prosperity-change cohort, all but one (ambulatory visits) demonstrated high-prosperity clustering. Thus, the healthcare consumption patterns of the HSAs that started in the highest prosperity quintile were globally no different whether those HSAs continued to see the highest prosperity or whether they saw dramatic economic declines; the highest-prosperity HSAs were, for nearly every metric, "immune" to economic decline.

Of the 19 total care metrics in this analysis, 7 (and at least one in each family of care metric) demonstrated both low-prosperity splintering and upward mobility (ambulatory visits demonstrating an extreme degree thereof). For these 7 metrics, increases in economic prosperity were associated with significant changes in healthcare usage patterns, away from those of the least-prosperous HSAs and toward those of the most-prosperous. Among this latter set of 7 metrics, all but one (ambulatory visits) showed additional evidence for high-prosperity clustering (and, hence, for all three prosperity-change phenomena of interest). Thus, for those 6 metrics, HSAs that saw dramatic improvement in economic conditions adopted healthcare use patterns that diverged from those of HSAs that did not see such improvement (splintering) and came to resemble those of the most-prosperous HSAs (upward mobility); further, the most-prosperous HSAs had healthcare consumption patterns that were "immune" to economic decline, suggesting that economic prosperity has a "stickiness" to geographic areas. Importantly, it does not appear that healthcare usage changes were due to shifts in Medicare enrollment, since enrollee population changes were comparable between HSAs with dramatic prosperity changes in either direction.

Our study was limited by its reliance on Medicare fee-for-service data, the time frame examined, and our use of DCI scores; different data sources, time periods, and measures of local economic activity might generate different results.

Despite these limitations, our findings add to a growing body of literature supporting that local economic conditions in the United States are associated with care quality, care costs, and care outcomes in both the older Medicare fee-for-service population,[8-12] and, recently, in a commercially insured population aged 40–64, where, between 2010–2017, improved local economic conditions were associated with relative decreases in cardiovascular, ischemic heart disease, and all-cause mortality rates.[13] Importantly, such work suggests that improvements in local economic conditions for specific populations may have health services utilization and quality consequences. Though per-capita Medicare costs may increase as care quality does, it appears that such increased spending may be more efficient. When conducting analyses of return on investment in improving local economic conditions, policymakers should consider improved healthcare quality and reduced avoidable and potentially unnecessary high-cost care as potential returns.

Conflict of interest: The authors have no conflicts of interest to report.

Authors' contribution: All authors contributed in a manner that warrants authorship. Mr. Wallace wrote the first draft, performed, the analytics, and wrote revisions. Mr. Fikri helped obtain data, helped with conceptualization, and contributed to revisions. Dr. Weinstein helped with conceptualization, administrative support, and revision contributions. Dr. Weeks helped obtain data, conceptualized the paper, provided administrative support, and contributed to revisions.

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