Doctors, Patients and the Racial Mortality Gap

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Abstract

Research in the health sciences reports persistent racial differences in health care access, utilization, and outcomes. This study investigates three potential sources of these disparities – differential quality of care, physician discrimination, and patient response to therapy. It uses a unique panel dataset of physician-patient encounters, the resulting medication therapies and the patients' adherence to those medical recommendations. Equalizing access to quality health care will not erase the racial differences in mortality from chronic conditions. Targeted programs aimed at improving adherence with medication therapy among disadvantaged groups must be an integral part of any policy aimed at achieving equality in health outcomes.

1. Introduction

Research in the last twenty years has uncovered persistent racial differences in health care access, utilization, and health outcomes (Institute of Medicine, 2002). A separate literature has studied the socio-economic (SES) gradient in health and mortality, identifying large differences in outcomes across socio-economic groups (for a recent overview, see Cutler and Lleras-Muney, 2011). Grossman (2006) discusses in detail the existing hypotheses that attempt to explain this phenomenon – disparate economic resources, dissimilarities in preferences, and differences in health-related knowledge. Due to the large economic and social disparities between races in the US, some of the mechanisms that drive the SES gradient likely contribute to the racial gap in health care utilization and outcomes.

In addition to the economic determinants that affect the SES-health gradient, racial segregation, provider discrimination and cultural dissimilarities between racial groups could play a role in shaping the racial mortality gap. First, African Americans may face systematically inferior health care, manifested in worse quality of facilities, fragmented access to care, and interactions with worse clinicians. Second, institutional or provider discrimination may lead to different treatments. Finally, minorities may respond differently to identical conditions of care. This study uses panel data of physician-patient interactions and the resulting medical therapy decisions to test whether and to what extent these channels contribute to the racial mortality gap.

We use data from the Veterans Health Administration (VHA), where access to health care is equalized, conditional of veteran status. The VHA also implements a fixed salary scheme that limits physicians' financial incentives to over- or under-provide treatment. This institutional set-up minimizes access differences between racial groups. In this study patients are followed through outpatient and pharmacy encounters for up to six years. Directly observing the pharmacological therapy prescribed to patients allows the construction of measures of patient adherence to physician

recommendations and of the compliance with clinical care guidelines by individual doctors. These measures are then used to empirically test for provider discrimination and differential patient response to prescribed medical therapy.

We document a significant racial difference in survival rates from a chronic condition even though the VHA operates an equal-access health care system. The magnitude is about two thirds of the gap reported by studies using Medicare data, indicating that equalizing access and financial resources across medical facilities could reduce the black-white gap by about thirty percent. Differences in SES across racial groups account for only 20 per cent of the gap. Differences in the quality of care obtained within health facilities are small. They account for at most 5 per cent of the survival gap. The largest difference is in patients' adherence to recommended clinical therapy. This implies that patient-, rather than health care system or provider-level factors are the most significant contributor to the observed racial gap in outcomes. This research also finds that there is no difference in survival rates among patients who observe therapy prescriptions.

2. Background and previous literature

The extant hypotheses explaining the racial gap can be grouped into three broad categories: institutional or geographic barriers to obtaining good health care, disparate returns to seeking care, and differences in patient health investment or responses to care. Most medical and public health studies have concentrated on documenting institutional and provider-induced barriers to equalizing health outcomes.

Institutional or geographic barriers to obtaining quality care

African Americans are more likely to experience discontinuities of care and concentrate in an inferior subset of facilities and physicians (Oster and Bindman, 2003). Studies have found that doctors

who primarily treat minority patients are less likely to be board certified and more likely to report not being able to provide high quality care to their patients (Bach et al, 2004). African Americans have restricted access to high-quality specialists and non-emergency hospitalizations. Moreover, poorer African Americans are treated by lower-quality and lower-volume cardiac surgeons (Bach et al., 2004; Mukamel et al., 2000; Rothenberg et al, 2004). This study finds that in an equal-access environment, physician-patient matching has little effect on the quality of care received by minorities.

When studying differences in outcomes induced by supply-side inequalities, such as inferior medical treatment, it is important to distinguish the role of racial segregation on the level of health facilities from physician-level factors, such as doctor-patient matching and discrimination. Previous studies diverge in their assessment of the relative contributions of within- and between-facility health care differences to the survival gap. This is the result of two main obstacles. First, data are rarely recorded on the level of physician-patient pairs. Therefore the survival gap remaining after controlling for average clinic quality is customarily assigned to within-clinic differences. This may be misleading if patient response to care also differs along racial lines. Second, in order to assess the clinical quality of care provided, we usually study conditions with clearly defined treatment guidelines and outcomes, such as in cardiovascular care. Assessing differences in 30-day, 6-month or 1-year mortality rates from AMIs is common in the literature (Bradley et al. 2004; Barnato et al. 2005; Skinner et al., 2005). However, patients being treated in emergency conditions are assigned doctors randomly at least in the first hours post- AMI. Therefore differences in short-term mortality rates are mostly driven by differences in average doctor and equipment quality between hospitals. The effects of doctor-patient matching are more likely to manifest over a longer time horizon and within a condition that requires regular interactions and follow-up.

Disparate treatment

Statistical discrimination, clinical uncertainty or stereotyping may result in differential treatment across racial groups (Balsa and McGuire, 2002). Clinical uncertainty might contribute to over- or under-prescription of therapies because doctors are less aware of the severity or of the appropriate treatment in the minority group. Statistical discrimination based on the doctor's perception of average behavior across SES or racial groups also results in treatment differences. For example, Bogart et al. (2001) demonstrate that doctors are less likely to prescribe certain medications to minority patients because they expect worse adherence to therapy.

Differences in patient response to care

Previous research shows that ethnic and racial minorities differ in their attitudes towards health and the health care system. There are several ways in which such attitudes may influence health outcomes. First, systematic differences in health investment over the life cycle will result in disparities in health outcomes. For example, Charles, Hurst and Roussanov (2009) demonstrate that African Americans spend about 56% less on health care than whites. They show that about 14 per cent of this gap is explained by differences in consumption preferences.

Second, differences in attitudes can manifest in discrepancies in adherence to prescribed clinical therapy. Poor adherence to medication therapy is a chronic problem of the health care delivery system, costing about one hundred billion a year in avoidable hospitalizations (Cutler and Everett, 2010). But we know little about the roots of this problem.

African American patients with cardiac conditions are less satisfied with the health care they receive and more likely to mistrust the system overall (LaVeist et al., 2000). Such differences in satisfaction with care and suboptimal physician-patient cooperation could lead to suboptimal outcomes. For example, Saha et al. (1999) find that minority patients who see minority physicians are

more likely to rate physicians highly and to report receiving preventive care. Patients holding negative stereotypes about their physicians are less likely to be satisfied with the care they receive and less likely to adhere to physician therapy recommendations (Bogart et al., 2004).

This paper investigates racial differences in the clinical treatment, patient response to treatment, and death rates after a diagnosis of chronic heart failure (CHF, or heart failure). There are several reasons to focus on this condition. First, heart disease is the leading cause of death in the elderly and is the single most costly condition in Medicare in recent years (33.2 billion dollars in 2007)[1]. Cardiovascular disease is a major contributor to the racial mortality difference, accounting for over 40 per cent of the gap.[2] Approximately 10 per cent of all inpatient admissions are for CHF and hospitalizations are about twice as frequent in black males as in white males[3]. Third, heart disease is classified as an ambulatory care sensitive condition, which makes it particularly susceptible to policy interventions in an outpatient setting. Finally, heart failure is rarely misdiagnosed, and there are clear guidelines for pharmacologic treatment. This study relies on the published clinical guidelines to construct a measure of doctor compliance with recommended therapy and to test whether doctors provide the optimal therapy to both racial groups.

Congestive heart failure is a progressive health disorder with fatal outcomes. Mortality rates in the first year after diagnosis are about 10 per cent. However, if care is managed well, patients' chances of living longer and their quality of life can be improved significantly. The recommended medical therapy is well publicized. Short-term (one-year) mortality is more likely to be influenced by the patient's initial physical condition at diagnosis, while longer-term survival is more sensitive to the

[1] According to the AHA statistical abstract, 2007 (http://www.americanheart.org/downloadable/heart/1166711577754HS_StatsInsideText.pdf)

[2] The largest estimate of the racial mortality gap in CHF was reported by the CDC - 7.8%. This is a very crude benchmark of the yearly mortality rate, unadjusted for the number of years since diagnosis or differences in access and co-morbidities. The closest estimate of the gap to the one reported here is found in a study using Medicare data by Dries at al (1999). They find a 3.1 percentage points higher probability of survival for white patients after two years of follow-up.

[3] In the population over 65 (Alexander et al., 1999; Joshi et al, 2004)

success of medical therapy and the ability of the patient and the doctor to coordinate the management of the disease. Appendix A discusses the medical condition and treatment options in more detail.

3. Data

The data come from the VHA Medical SAS inpatient and outpatient datasets, the Beneficiary Identification Records Locator Subsystem (BIRLS) death files, the VHA Enrollment files, and the Veterans Service Support Administration (VSSA) clinic performance measures database. The data cover all outpatients who were diagnosed with chronic heart failure in the VHA between October 1998 and October 2004[4].

Between 1998 and 2004, the majority of veterans belonged to age cohorts who served in World War II, the Korean War, and the Vietnam War. The median age of all veterans was 55, with veterans comprising the majority of all males older than 65. The proportion of veterans varies by race. The sample is restricted to patients who utilized community based outpatient clinics at least twice in the first year after CHF diagnosis. Individuals whose race could not be verified either across visits and/or by using the inpatient datasets and Medicare data were excluded from the analysis. There were 2487 patients whose race could not be determined because the different datasets reported it differently.

The analysis sample consists of male veterans only. Female veterans comprise less than 2 per cent of the veteran population served by the VHA and diagnosed with CHF. The final sample consists of 48972 VHA patients. CHF disproportionately affects elderly people and the military had restrictions on enrolling African Americans until the Korean War. These two facts explain why African Americans

[4] All outpatient visits are recorded in the outpatient files. Hospitalizations in a VA or related hospital are recorded in the inpatient files. The Enrollment files use Social Security administration data, as well as the VA's internal accounts to record death. The BIRLS files pool data from the veterans benefits administration (including death/burial benefits) as well as notifications from hospitals (through the inpatient files), relatives/acquaintances, cemeteries or any other branch of the veterans system. Death data were initially extracted from the VA BIRLS files, double checked against the VA enrollment files, and then checked again against data from Medicare. The triple-checking of the death data ensures the use of accurate vital status records.

are underrepresented in this sample compared to the overall veteran population and to the US population in general. African American patients comprise about 7.6 per cent of the sample[5].

Table 1 presents means of variables used in the analysis. This study uses individual annual income as a proxy for socio-economic status. Previous studies using Medicare data control for income using mean or median zip-code of residence income data. However this measure can be misleading especially when the emphasis is on the correlations between SES or the predictive power of race on health. Segregated neighborhoods may have wider variations in income. Median income would then over-estimate the financial means of the minority population.

Table 1 shows that minority patients in the sample are, on average, about 25 per cent poorer. The differences in income reported in the sample are close to those observed in Census data for the same age groups. White patients are also more likely to be married.

The VHA outpatient datasets contain data on all coexisting health conditions. The controls for co-existing health problems here correspond closely to the conditions used in constructing the Charlson-Deyo index of co-morbidities, which is standard practice in the medical literature [Charlson, 1987][6]. Separate indicator variables are constructed for each of the conditions. The data do not supply an indicator of CHF severity, which is likely to differ across patients. However, there is significant information on other cardio-vascular co-morbidities. CHF usually occurs as a result of, or in conjunction with some of these conditions. Indicators for other cardiovascular diseases are included as proxies for the severity of CHF.

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[5] LaVeist (1994) among others points out that race is a poorly measured variable whose designation varies depending on the reporting body. The records used here have been double-checked with Medicare data. Nearly 90% of the patients have a record in Medicare. The remaining 10% use only the data from the Veterans Affairs administration, and are cross-checked with data from different encounters. S. Arday et al. (2000) show that the Medicare race variable corresponds very closely to self-reported race. For the part of the sample which has a record both in Medicare and in the VA, 3% of the patients had a difference in the coding of race between Medicare and VA. This discrepancy can be attributed to coding errors on both sides and is unavoidable in administrative data.

[6] Included controls are for: old myocardial infarction, lymphoma, leukemia, pulmonary failure, diabetes, renal failure, colon cancer, angina, cardiomyopathy, ischemic heart disease, prostate cancer, liver disease, dysrhythmias, other cardiovascular disease, other cancers.

The sample covers the period from October 1998 to October 2004. Patients join the sample throughout this period. The largest numbers of new patients enter in years 2001 and 2002. This coincides with the period of largest expansion of the VHA health care system. The years 1998 are 2004 are incomplete, since 1998 includes data from the last three months of the year and 2004 ends in September. A potential concern is that the patients joining the VHA health system after 1998 could have had an advanced stage of CHF at the time of observed first diagnosis *within* the VHA. This bias should be alleviated by including cohort dummies. Most of the new patients who joined the VHA after 1998 are white patients with higher income[7]. Therefore, any discrepancy in severity at first diagnosis would work against finding racial differences in survival.

Because minorities on average have lower socio-economic status and tend to delay seeking health care, it is likely that hospitals with high minority populations are also "sicker" or poorer hospitals. The centralized budgeting system of the VHA is government-sponsored, and the SES of the patients does not influence the resources of the clinic. Clinics that serve more patients get more funding. Over the observation period physician visits, procedures and hospitalizations were virtually free, and prescription drugs heavily subsidized at prices lower than Medicare prices[8]. Co-payments were still in the process of being introduced and were required only from enrollees with the highest SES and no service-related conditions.

Patients must maintain a primary care physician in the VHA and could only obtain prescription medications at subsidized prices if those medications were prescribed by a VHA physician. Primary care physicians are assigned at the clinic level when the patient makes his first outpatient visit. While it is possible for a patient to request a certain doctor, assignment usually happens on the basis of

[7] This is because the 1996 reform of the VHA relaxed the low-income condition on receiving VHA care. After the condition was relaxed, all veterans became potentially eligible for VHA care regardless of income levels.
[8] As of November 2007, the price of a refill for any medication was 8 dollars. Patients could obtain free refills if they passed a means test.

physician availability at the time of first visit. This fact becomes important when we consider the effects of physician compliance with clinical guidelines.

A physician-patient pair is defined as a match between a patient and a doctor who have more than two outpatient interactions in a year. The indicator of an interaction is a new prescription written by the doctor for the patient. Patients see a number of doctors over the course of treatment. African Americans see more doctors, but they get fewer prescriptions per doctor, implying that the intensity of their relationship with any given physician is lower. Another indicator of lower interaction intensity is that it takes minority patients on average two months longer to first encounter their main physician, defined here as the physician who wrote the largest number of prescriptions for them. The chances that the main doctor leaves the clinic in any given month are the same for both racial groups.

Clinics vary in size from 1000 visits per year to 300000 visits per year. For the sake of comparison, the means table divides clinics into small (below 10000 visits per year), medium (between 10000 and 20000 visits per year) and large (above 20000 visits per year) categories. The ratio of African American patients in the clinic is defined as the ratio of visits by minority patients in a year divided by the total number of visits to the clinic in that year[9]. Minority patients are more likely to be treated in large urban clinics (92% of African Americans visit urban and 55% visit large clinics), while white patients are more likely to go to small and medium-sized clinics. Table 1 shows a break-down of the racial profile of the clinic by clinic size and patient race.

3.1 Defining physician compliance with clinical treatment guidelines

[9] The data allow the construction of two measures of clinic racial mix. The other possibility is the ratio of minority to total patients. The proportion of visits is a measure of the intensity of black patients' presence at the clinic. It can be understood as the likelihood of meeting a black patient in the waiting room. While there may be significant number of African Americans registered at the clinic, they may not utilize it as much as the rest of the patients. However, there may be a number of them who showed up once at the clinic and never came back.

Data on prescribed therapy together with the clinical guidelines set out by the American College of Cardiology are used to create a measure of physicians' compliance with recommended treatment guidelines. The clinical guideline recommends prescribing Angiotensin Converting Enzyme inhibitors (ACE inhibitors, or ACEIs) and beta blockers (BBs) to all patients with a diagnosis of chronic heart failure. Widely publicized clinical trials in the 90s showed significant survival benefit from these medications. Further discussion of the clinical trials and the medical evidence is presented in Appendix A.[10]

The measure of providers' compliance with clinical guidelines is constructed as the ratio of the outpatients regularly[11] seen by the doctor who were prescribed ACE inhibitors and beta blockers by that doctor to the total number of patients regularly seen by the doctor[12]. The measure varies by year.

Physician compliance ratio = ((N patients with ACEIs-BBs)/(Total N patients with CHF))

A higher compliance ratio indicates stricter observance of the recommended therapy guidelines. Summary statistics by clinic size and race of patient are presented in Table 1. This measure is directly estimated from data, and it is based on the actual decisions taken by the physician. While it is a popular measure in constructing hospital quality indices, it has not been used in outpatient data analysis.

Some patients see more than one doctor every year, so we construct the weighted average of physician compliance for every patient in every year. The weights are based on the number of prescriptions written by the doctor for the patient during the course of treatment. For example, if a

[10] The only exceptions may come from allergies. There is no evidence that black patients are more likely to suffer from allergies to ACEIs and beta blockers. However, at least one guideline suggests that finding the correct dosage may be harder with African American patients and hence more careful patient monitoring is advised.
[11] At least twice a year with a resulting therapy prescription
[12] Similar measures have been proposed by the Pay for Performance initiative, whereby physicians will be compensated on the basis of their compliance with standard practice guidelines.

patient has seen two doctors, and he has 5 prescriptions from the doctor of compliance rate 1 and 2 prescriptions from the doctor with compliance rate 0, his mean doctor compliance measure is 5/7.

Figure 1 shows a histogram of the distribution of black and white patients within doctor compliance quintiles. We use doctor compliance with guidelines and doctor clinical quality interchangeably in the text. African American patients are more likely to see doctors in the bottom and third quintile, and less likely to see doctors in the top 2 quintiles. In the empirical analysis below, we test whether differential doctor-patient sorting across doctor quality is the driving factor behind the racial gap.

3.2 Measuring patient adherence with medication

Patient response could be especially important for chronic conditions such as chronic heart failure that are managed on an outpatient basis, and that require an investment of daily effort by the patient. Medications do not work on patients who do not take them. Leonard and Zivin (2005) provide one of the few models of health production that explicitly accounts for patient input.

Data on prescription refills are used to define a measure of patient adherence to therapy. The pharmacy data contain a "days supply" variable attached to each prescription, as well as the date on which the first dose was dispensed and the dates of subsequent refills. The "days supply" variable helps determine whether the prescription was refilled on time. A refill is defined as “compliant” if it was picked up within 3 days of the expiration of the previous refill’s days’ supply[13]. The medication adherence measure is defined as the number of refills that were picked up on time (before the expiration of the “days supply” of the previous fill) over the total number of prescription refills. The

[13] The choice of 3 days is intended to get around potential pharmacy closures on weekends and holidays. Patients whose previous supply expires on a Friday would not be able to obtain a re-fill until the following Monday (or Tuesday, for long weekends), even though they may have called it in on time. Even if pharmacies maintain weekend hours, some patients may be unwilling to go and pick up medications on Saturday or Sunday. Different time windows were considered ranging between 1 and 7 days. The results were very similar across measures.

same methodology is used to formulate average patient adherence per year and yearly patient adherence specific to every patient-doctor pair.

Compliance ratio = ((N prescriptions filled on time)/(Total N prescriptions))

While this measure is an imperfect marker of the actual health investment by patients, it provides some measure of patient response to clinical treatment. According to a comprehensive study of medication adherence measures, this is the best that can be constructed from pharmacy data (Ostenberg and Blaschke, 2005). Further discussion of the different ways to define patient adherence and the effects of adherence on mortality and hospitalizations is presented in Appendix B.

Table 1 shows summary statistics of medication adherence. The average adherence rate in the sample is fifty percent, and black race is associated with a 3% to 5% lower adherence. We do not directly observe whether medication was taken correctly on the occasions when it was taken, so this measure likely overestimates adherence for all patients. This implies that the estimates of the effect of adherence on outcomes reported here are more likely attenuated towards zero.

Picking up a refill late might not be as important as *how late* the patient is. For example, missing one day of therapy is less likely to have dire consequences than missing one week. This is why in addition to the patient adherence measure introduced above we report the average lapsed time per refill in Table 1. When late picking up a refill, minority patients are on average an extra week behind their therapy regimen. The same level of average non-compliance implies a much larger lapse in treatment among minority patients.

4. Empirical Strategy

We formulate the following conceptual model of patient survival:

Patient Survival = F(patient characteristics, clinic quality, provider input, patient response)

There are three types of variables in this model: 1) patient characteristics, including the patient's response to therapy; 2) clinic characteristics such as the clinic geographic location that are constant over time; 3) clinic or doctor-level characteristics that change over time.

The empirical analysis starts by documenting differences in patient medication adherence and doctor compliance with guidelines – two of the main inputs into the health production function. We first test for basic descriptive correlations between demographic variables and yearly patient adherence with medication therapy:

$$y_{gtm} = \alpha + \beta X_{gtm} + \rho * black + \varepsilon_{gtm} \quad (1)$$

Where the outcome is the average patient's yearly adherence with all medications prescribed by all treating physicians. X_{gtm} is a vector of demographic and health characteristics for patient m who goes to clinic g at time t. Cohort dummies are included in X_{gtm} to control for differences in characteristics of patients being diagnosed in different years and for changes in the aggregate technology of treatment which affect all patients diagnosed in the same year.

The basic model is expanded by adding clinic fixed effects (μ_g) to capture unobserved clinic characteristics that do not vary by year. In addition, the proportion of minority patient visits per year and the total number of patient visits per year are added as controls in B_{gt}. The specification becomes:

$$y_{gtm} = \alpha + \beta X_{gtm} + \rho * black + \delta B_{gt} + \mu_g + \varepsilon_{gtm} \quad (2)$$

To test how patient adherence is influenced by physician-patient matching we estimate several specifications of (2) including physician fixed effects, so that g indexes the physician, rather than the clinic. The dependent variable is re-defined as the patient's yearly adherence with clinical therapy prescribed by the individual physician.

To test for differential treatment by physicians, we run linear probability regressions where the dependent variable is a binary indicator equal to one if the physician prescribed the clinically recommended therapy to the patient during the calendar year. In a specification including physician fixed effects the coefficient on black race – ρ - thus captures racial differences in treatment prescribed by physicians.

Finally, we consider the relative contributions of demographic, clinical, and patient behavioral factors on patient survival probabilities. We run the basic models (1) and (2) first, changing the dependent variable to a binary indicator of patient survival. We then add a measure of the average compliance with the clinical guidelines by physicians treating the patient (D_{gm}). The coefficient estimate on this variable measures the effect of observing the clinical treatment guidelines on survival. If differences in survival are due to systematic matching of minority patients into less compliant doctors, controlling for doctor compliance should reduce the magnitude of the race coefficient ρ in this model compared to the estimate obtained from the basic model (1). To test whether the efficacy of observing the clinical guidelines differs along racial lines, we add an interaction term of physician compliance and patient race. The coefficient on the interaction term captures differences in the marginal productivity of compliance with guidelines across races.

$$y_{gtm} = \alpha + \beta X_{gtm} + \delta B_{gt} + \rho * black + \gamma D_{gm} + \theta * black * D_{gm} + \mu_g + \varepsilon_{gtm} \quad (3)$$

where the coefficient θ measures such differences.

Finally, we add a control for the patient's adherence with medication therapy. If differences in patient effort contribute to the racial mortality gap then controlling for patient adherence in the survival regression will reduce the magnitude of the race coefficient ρ. However, the marginal product of patient effort may also vary by race. The following specification introduces patient adherence E_{gtm} into the survival model as follows:

$$y_{gtm} = \alpha + \beta X_{gtm} + \delta B_{gt} + \rho * black + \gamma D_{gm} + \theta * black * D_{gm} + \pi * E_{gtm} + \xi * black * E_{gtm} + \mu_g + \varepsilon_{gtm} \quad (4)$$

where π and ξ capture the contribution of patient adherence to patient survival and the difference in the marginal product of adherence by race.

5. Results

5.1 Patient adherence with medication therapy

Several levels of patient adherence are examined in this study. Average yearly adherence to therapy across all doctors and all medications is the first and most aggregated measure considered. Doctor- and medication-specific adherence rates are also investigated.

African American patients are less likely to adhere with prescribed therapy. Table II reports the estimates from a series of regressions estimating the effect of demographic characteristics on the average yearly patient adherence. The raw black-white medication adherence gap is 2.4 percentage

points, or one tenth of a standard deviation. Income does not significantly affect adherence. This is somewhat surprising, but it might be explained be the low (fixed) price of a refill within the VHA pharmacy system. Married veterans have higher adherence than unmarried ones. The beneficial effects of marriage on male patients' adherence with medication agree with results in Goldman and Smith (2002). The specification in column (3) of table 2 controls for outpatient-clinic-specific fixed effects. Controlling for clinic characteristics increases the measured racial gap in adherence. Within the same clinic, and after controlling for health and SES, African American patients are 3.6 percentage points less likely to pick up medications on time. Controlling for differences in clinic unobservable characteristics increases the magnitude of the black race coefficient, suggesting that minority patients visit clinics with better average patient adherence levels.

It is possible that unobserved (within-clinic) differences between doctors account for the observed racial differences within clinics. Table 3 focuses the analysis on the interaction between individual doctor-patient pairs. Racial differences in adherence persist after controlling for unobserved doctor characteristics. In the specification with doctor fixed effects in Column (3), African American race is associated with 5.6 percentage points lower adherence. This implies that within the same clinic, minority patients see physicians who on average have more adherent patients. Therefore physician-patient matching works in favor of closing the racial gap in health behaviors. If everyone saw the same doctors, minorities would be about 40 per cent (1.8 percentage points) less compliant than if they self-selected physicians. In the context of adherence to therapy, patient matching into different providers is efficient.

Patient response may vary across different types of medication and the patterns of non-compliance may differ with race. For example, more educated patients with more health knowledge capital (who are more likely to be white) may selectively adhere more to medication therapy that is

recommended by the clinical guidelines. A separate measure of patient adherence with ACE inhibitors and beta blockers is constructed to test this hypothesis.

Not all patients received prescriptions for these medications. An estimation of average adherence with all medications using the subsample of patients who were treated with ACE inhibitors and beta blockers yielded a coefficient on black race -0.035, which is very similar to the coefficient obtained from the identical specification with the whole sample (reported in Column (3) in table II). Column (4) in Table II reports the coefficients from a linear regression of average yearly patient adherence with prescriptions for ACEIs and BBs. Minority patients who were prescribed these drugs were even less likely to pick up their refills on time. Therefore the racial gap in adherence is wider in clinically recommended drugs.

Table IV shows the corresponding results from specifications using data on patient-doctor pairs. Column (1) reports coefficient estimates for adherence with all medications for the subsample of patient-doctor pairs that produced at least one prescription of ACE inhibitors and beta blockers. The coefficient on black race is -0.062, i.e. on average minorities comply even less with therapy-prescribing physicians for *all* medications that those physicians prescribe.

5.2 Do doctors treat minority patients differently?

Table V reports the coefficient estimates from a series of linear probability regressions estimating the probability that a patient would be prescribed a combination of ACE inhibitors (ACEIs) and beta blockers (BBs) by a doctor. Column (1) reports the basic specification controlling for black race, age and co-morbidities only. Column (2) adds controls for income and marital status. After controlling for SES, on average black patients appear slightly less likely to be prescribed the recommended therapy. The coefficient is only marginally statistically significant and about one tenth

of a standard deviation in physician compliance with guidelines. There are two possible underlying mechanisms. First, minorities may be treated differently by all doctors. Second, they may be seeing a different mix of doctors.

If doctors treated black and white patients differently, there would be differences in the probability of prescribing the clinically recommended therapy by patient race within doctor. To test this hypothesis, we include doctor fixed effects in the specification in Column (3) of Table IV. Controlling for physician fixed effects erases the racial difference in prescription patterns. The evidence in columns (2) and (3) suggests that African American patients are slightly less likely to match into physicians strictly following the clinical guidelines. Contrary to patient adherence, physician-patient matching may result in inferior quality care for minority patients as measured by observance of clinical guidelines. Below we examine the relative contributions of physician compliance with therapy and patient adherence with medication to the racial gap in survival from CHF.

5.3 What are the determinants of the survival gap?

No significant racial differences in survival were found in the first two years after diagnosis in this sample of VHA patients. There are at least two reasons why the racial gap may not immediately manifest after initial diagnosis. First, unobserved differences in severity at first diagnosis could bias the short-term survival estimates. Second, medical studies show that racial differences in mortality first appear around the 20th month after initial diagnosis[14]. Table VI reports the results of a linear probability regression estimating the probability of surviving the third year after initial diagnosis, conditional on surviving the first two[15]. Columns (1)-(4) report results from specifications including an

[14] Appendix A discusses findings in the medical literature that lend support to this approach.

[15] One- and two-year survival estimates are available upon request. Different specifications were estimated including the square of age, as well as using age cohorts rather than a linear continuous measure of age. These yielded similar results to the main model reported in table VI.

expanding set of controls. Column (1) shows estimates from a basic model including only controls for age and co-morbidities. The results can be used as a benchmark to compare the current study's estimates to previous studies using Medicare data. On average, African American race is associated with 2 percentage points lower probability of survival. This estimate is smaller than coefficients obtained in studies using private care data and a similar survival window (e.g. Dries et al, 1999).

Testing for the effect of socio-economic factors

Differences in socio-economic status between minority and white veterans do not account for the racial gap in survival. Controls for personal annual income and marital status are added to the basic specification in Column (2). The coefficient on black race is diminished and loses some statistical power. Personal annual income does not predict improved chances of survival. First, equalized access to care within the VHA may render income less important for survival. Second, personal wealth and life-long income may be more important for survival than contemporaneous income. Married veterans have about three percentage points higher chances of survival. Differences in socio-economic status account for about 22 per cent of the basic survival difference estimated in (1). However, a significant negative correlation between black race and the probability of survival still exists.

Testing for the effects of clinic quality

Between-clinic differences in quality of care also do not explain the racial mortality gap. The specification in Model (3) includes clinic fixed effects that control for average clinic quality and other unobserved clinic-level characteristics which do not vary over time. Observable time-variant clinic characteristics - the ratio of black patients in the clinic in every year, and the number of visits to the clinic in the year are also included as controls. The coefficient on the race dummy becomes larger in absolute value and maintains a negative sign. Minority VHA patients appear to be visiting similar in quality or even clinically *better* clinics.

Physician compliance with clinical guidelines

Physician compliance with recommended clinical guidelines matters for patient survival. Going to a top-complying doctor improves the probability of survival by two months relative to visiting a non-complier. The model in Column (4) of Table VI includes a measure of mean doctor compliance with clinical guidelines. The effect of clinical quality is large and statistically significant[16]. Levels of compliance with clinical guidelines do vary within clinics, and they have an independent effect on survival. However, including controls for physicians' average observance of guidelines reduces the coefficient on black race by only 5 per cent.

To test for differences in the marginal product of doctor quality across races, the model in column (5) adds an interaction term between the average physician's compliance with guidelines and black race. The difference in the marginal productivity of clinical compliance seems to explain away the racial mortality gap. Black patients benefit from it half as much as white patients do. We test whether this effect is linear with respect to doctor quality. Figure 2 plots the regression coefficients obtained from regressions of the survival probabilities on dummies indicating the doctor clinical compliance quintile. The omitted category is the lowest quintile (lowest doctor clinical quality). Minority patients receive lower benefits at all levels of doctor compliance with guidelines, but the largest difference occurs in the middle range of the distribution. In practical terms this means that reassigning a white patient from doctors with average clinical compliance in the lowest quintile (<0.2) to doctors with average clinical compliance in the top quintile (>0.4) will increase his relative chances of survival by 8 percentage points. An equivalent exercise for an African American patient will increase his chances of survival only by 4 percentage points.

[16] The results reported here correspond closely to findings in clinical trials where patients were randomized into ACEIs and/or BBs and a placebo (see Appendix A for a brief review of some of this literature). The effect of having doctors who prescribe the recommended therapy to all their patients closely corresponds to the mortality advantage found in patients randomized to the recommended therapy in clinical trials.

Robustness of the doctor compliance measure

A problem arises if doctors more likely to follow clinical guidelines are matched to patients of better health along dimensions not captured by the controls. The coefficients on doctor quality would then be biased upwards. Positive matching of doctors to patient populations is more likely at the clinic level, i.e. doctors choose a clinic based on the clinic's patient population. It is less likely that doctors would be allowed to choose patients within a clinic. The clinic fixed effects guarantee that the effects on patient survival are identified only by the variation across groups of doctors within the same clinic, and not by how doctors are distributed among clinics. However, it is still possible that doctors are non-randomly matched to patients within clinics. This is more likely to happen over time, i.e. in the course of patient tenure with the clinic both patients and doctors learn about each other's characteristics. That is why as a robustness check we also use the quality of the *first* doctor who prescribed medication for CHF. This is intended to alleviate possible effects of assortative matching between doctors and patients *within* clinic[17]. In Table VII Columns (3) and (4) the controls include the average compliance rate of the first doctor who is observed treating the patient instead of the average physician's compliance rate. The coefficient estimates do not change appreciably. Minority patients benefit from physicians observing the clinical guidelines about half as much.

5.4 The effect of patient adherence on survival

If racial differences in patient adherence with medication explain the racial mortality gap, including a measure of adherence with prescribed therapy should reduce the gap in survival. This hypothesis is explored empirically in Table VIII. Studies in the medical literature define patients as

[17] The education literature offers the closest type of problem to the one discussed here. Studies attempt to estimate the importance of teacher quality on students' performance independently from the effect of schools, selection into schools, and students' family background. Rivkin, Hanushek and Kain (2005) provide an excellent review of the problem in the education context and discuss the challenges to obtaining robust empirical estimates of the effect of teacher quality.

"fully compliant" or "fully adherent" if they obtain more than 80 per cent of re-fills on time (Rossack, 2004; Ostrop et al, 2000). The effect of improved adherence on survival is non-linear, i.e. only patients who are at the top levels of adherence do better than the rest. That is why we follow the medical literature and define an indicator equal to one if the patient has an adherence rate of over 80 per cent.

One potential problem is that adherence may in itself depend on unobserved factors that correlate with physician compliance with clinical guidelines. Adherence in the first year after diagnosis should be less affected by physician-patient matching, since assignment to physicians is more likely to be random. That is why an indicator of the patient's full adherence (over 80%) with the first doctor who prescribed CHF medication is included as a control in the survival regression. Column (2) in Table VIII reports the regression estimates after a dummy for adherence levels of over 80% is included in the model. Controlling for full patient adherence with the first encountered treating physician does not significantly reduce the effect of physician compliance with clinical guidelines and the magnitude of the coefficient on black race. Differences in adherence levels do not explain differences in survival between minority and white patients, even though patient adherence with medication is important for survival. The magnitude of the full patient adherence coefficient is comparable to the magnitude of the coefficient on black race.

The model in Column (3) includes an interaction term of the full adherence indicator with black race, intended to test whether the marginal returns to full adherence are smaller for African Americans. The coefficient on the interaction term is positive and important in magnitude, even though it is not precisely estimated. Fully adherent minority patients are more likely to benefit from adherence relative to their less adherent peers than fully adherent white patients.

Differences in patient adherence across groups of patients may be driven by differences in patient perceptions about the substitutability of medical care and their own efforts. If the marginal cost of own investment in health is high, and the patient perceives the two inputs as substitutes, he will tend to rely more on medical care and less on his own effort. For example, those who find it too painful to change lifestyle and diets would tend to substitute into more potent medication or more frequent hospitalizations. If there is a high degree of substitutability between received and self-managed health care, the effect of doctor compliance, to the extent that compliance signals effort, should be stronger for less adherent patients. Depending on the degree of substitutability between patient effort and doctor effort, higher quality medical care may compensate for lower patient effort. Moreover, the degree of substitutability may differ with patient health knowledge capital.

To empirically explore these relationships and their effect on the racial mortality gap, we test for the effect of physician compliance with recommended guidelines on two patient subsamples – those with average adherence above the mean and those with average adherence below the mean[18]. Table IX reports the results from a series of survival regressions on the samples of adherent and non-adherent patients. The coefficient on doctor compliance with clinical guidelines in the non-adherent sub-sample is slightly larger than the respective coefficient in the adherent subsample (comparing models 1.2 and 2.2 in Table IX). This suggests that the marginal product of medical care may be higher among non-adherent patients, so there is some substitutability between own effort and medical care. However the estimates are not precise enough to draw any strong conclusions. The reduced marginal product of compliance with medical guidelines for minority patients is isolated to the mostly non-adherent part of the population. In fact, there are no racial differences in survival among those

[18] This cut-off was chosen to obtain similarly sized subsamples. A potential concern is that selection into medication adherence is influenced by the doctors' clinical quality. A probit regression of the binary above/below mean adherence indicator on observables shows no significant effect of the rate of observing clinical guidelines on selection into above mean adherence.

who adhere to prescribed therapy and there are no differences in the efficacy of recommended clinical treatment across races in that subsample.

Why is this differential effect of medical care quality restricted to non-adherent minority patients? There are several possible explanations. First, non-adherence in whites may be different from non-adherence in minorities. For example, when late picking up a medication, black patients take longer than whites. A longer lag between filling prescriptions bears additional negative association with survival. Moreover, as we saw in the preceding analysis, the racial gap in adherence in larger in clinically recommended drugs.

Second, it is possible that the reasons for suboptimal adherence may be different in the two samples. For example, whites do not pick up a medication because they are feeling well, while African Americans are late because they are too weak to go to the pharmacy. Third, lower income and weaker social support may play a significant role. For example, a white non-adherent patient may have more alternative venues of obtaining the medication. Unfortunately the data do not allow distinguishing between these hypotheses. A comparison of means of observable patient characteristics between (50% and over) adherent and (50% and less) non-adherent patients by race is presented in Appendix C. The only significant observable difference between the non-adherent and adherent subsamples is in age – the white-black difference in age is twice as high in the non-adherent sample as it is in the adherent one. This age difference and the fact that white non-adherent patients are by far the oldest subgroup, suggest that more frequent inpatient stays might drive the racial difference in benefits from clinical quality care in the mostly non-adherent sample.[19]

The results presented in this section have several important implications. First, minority patients are less adherent with medications regardless of who their doctor is. Second, patient effort is

[19] Inpatient stays would thus serve as a substitute for outpatient visits among white non-adherent patients. Unfortunately there is no data on Medicate hospitalizations for this sample and so this hypothesis is untestable within the scope of this study.

an important component of the health production function. Strict patient adherence to the prescribed medication regimen yields positive health results regardless of the physician's compliance with clinical guidelines. Third, the entire racial gap in survival is isolated among non-adherent patients. In practice this means that sending a non-adherent minority patient to the most conscientious doctor would result in the same survival benefit as sending an adherent minority (or white) patient to a doctor of average quality.

5.5 External validity

This study analyzes patient behavior and the determinants of the racial gap in survival using a sample of male veterans actively utilizing VHA facilities. With the appropriate caveats the results presented here can be interpreted more broadly. This section explores some of sources of bias and how they would affect the estimated gap in this sample as compared to the general population.

While military training and service is likely to have influenced all veterans in a similar fashion with respect to health and health habits, veterans who use the VA health care system are subject to at least two selections. First, the individuals represented in this sample have self-selected into military service except for a tiny fraction of Vietnam veterans who were drafted. Second, they have chosen to use the VHA rather than private care for their health needs. The more problematic possibility is that the selection may have happened differently among different racial groups. Data from the National Survey of Veterans and the Current Population Survey from March 2000 are used to assess the potential bias in the mortality gap induced by this selection. Appendix C presents the evidence discussed in this section.

More than half of the male population (56%) over the age of 65 had veteran status in 2000. Correlation coefficients between veteran status, marital status and education for minorities and whites

in the population over 65 and in the general population are reported in Table C.2. Veteran status captures the top of the socio-economic distribution of African Americans and the middle of the socio-economic distribution of whites. Veteran status serves as a mediator of the racial gap in education. It closes about one third of the gap (see Table C.2). Higher education has been found in numerous studies to positively influence health and correlate positively with adherence to therapy. Hence, the selection into veteran status by African Americans would bias the black-white mortality gap found in this study *downwards* compared to the general population.

The National Survey of Veterans (NSV) from 2000 is used to assess the potential bias arising from selection into VHA care conditional on being a veteran. Table C.3 in Appendix C reports some suggestive evidence. The 2000 NSV is a nationally representative survey of veterans that asks several questions related to the use of VHA care and about veterans' health status and chronic conditions. Within the veteran population of patients over 65, relatively better educated African Americans chose VHA, while better educated whites chose Medicare. Across races, married individuals were less likely to use VHA care. There were no significant racial differences in income between VHA and Medicare patients. Similar comparisons apply to the sample of patients who report having a heart condition. The best educated minority patients and the average whites are likely to end up in VHA care for CHF. The double selection would likely bias downward the racial mortality gap among veterans using VHA relative to the general population.

6. Policy implications

How much of the racial mortality gap is due to unequal access and unequal treatment? If patients were universally insured and there was a central health care budget, would the racial gap in CHF survival change? This study implies that at least one third of the racial survival gap measured in

private care could be accounted for by disparate access and quality due to financial constraints such as individual access to insurance and hospital financing. However, equalizing the quality of facilities and physicians would not close the entire gap.

The most sizeable contribution to diminishing disparities would come from changes in physician and patient inputs into the health production function. Designing patient-centered care processes and implementing policies that improve physicians' awareness of clinically recommended therapies and patients' response to therapy will have first-order effects on overall mortality and in particular on the racial gap in survival.

Increasing average minority patients' therapy adherence by 5 per cent and equalizing it with white patients' adherence will reduce their absolute medium-term mortality by 1.5 per cent. More than one in three adults in the US today live with a cardiovascular condition and the health care system spent over $34 billion on treating heart failure in 2010 (Centers for Disease Control, 2011). Potential reductions in the cost of care and benefits to society are in the order of billions of dollars.

7. Conclusions

This study finds that equalizing health care access for patients and financial incentives for physicians is not sufficient to close the racial mortality gap in elderly patients suffering from chronic heart failure. Several reasons for this phenomenon are examined. Differences in socio-economic status account for less than one third of the remaining gap in survival. While doctor compliance with clinical guidelines is a significant factor, there is little evidence of sorting of minorities into less compliant doctors. Patient-doctor matching is efficient in improving patient medication adherence. It is noteworthy that we find no evidence of disparate treatment by physicians. Rather, divergent patient responses to provider input appear to trigger some of the differences in survival.

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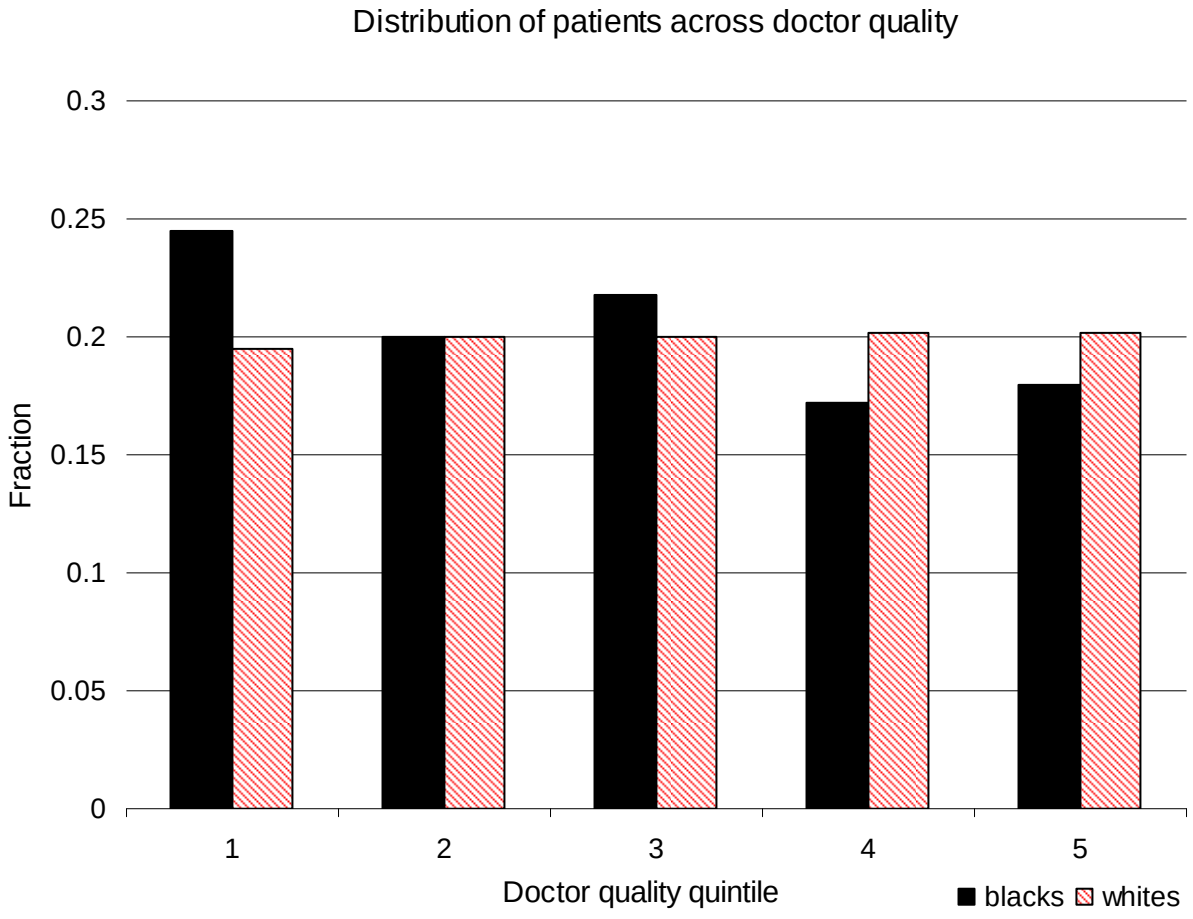
Tables and Figures

Table I: Variable definitions and means

	White patients			*Black patients*		
Variable	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
Yearly income	45512	24890	20000	3460	18644	10500
Age	45512	73	9	3460	67	12
Married	45512	0.70	0.46	3460	0.50	0.50
Patient compliance (all)	41436	0.49	0.28	3074	0.53	0.28
Patient compliance (ACEIs-BBs)	32716	0.56	0.29	2611	0.51	0.29
N days late with refill	39929	17	18	3152	22	22.5
			Outcomes			
% Survived the first year	45512	84%	0.37	3460	87%	0.34
% Survived the 2nd year|surviving 1st	26365	86%	0.43	2141	88%	0.41
% Survived the 3rd year|Surviving 2nd	17681	89%	0.46	1566	90%	0.44
			Clinic characteristics			
Ratio black in clinic	45167	5.57%	7%	3455	15.13%	12%
% in Small clinics	45512	25.53%	44%	3460	16.82%	37%
% in Large clinics	45512	34.63%	48%	3460	54.57%	50%
% in Rural clinics	45314	11.77%	17%	3385	7.79%	14%
			Patient-doctor matching			
Doctor ratio black	40639	0.06	0.078	3243	0.245	0.18
Mean doctor quality	40639	0.29	0.09	3243	0.28	0.09
First doctor quality	40639	0.34	0.08	3243	0.33	0.08
Time to meeting main doctor (days)	40639	254	421	3243	303	478
N doctors /year	40639	1.6	0.2	3243	1.8	0.2
N prescriptions/doctor	40639	8.5	0.3	3243	8.2	0.4
main doctor absent (months)	40639	2.8	3.87	3243	2.8	3.66
			Small clinics			
Doctor ratio black	10631	0.04	0.06	545	0.28	0.24
Doctor compliance with guidelines	10631	0.3	0.09	545	0.3	0.1
			Medium clinics			
Doctor ratio black	15775	0.05	0.06	896	0.19	0.008
Doctor compliance with guidelines	15775	0.29	0.087	896	0.28	0.04
			Large clinics			
Doctor ratio black	14233	0.09	0.09	1802	0.26	0.17
Doctor compliance with guidelines	14233	0.29	0.09	1802	0.27	0.09

Figure 1: Average physician compliance with guidelines by patient race. Shaded red indicates white patients, black denotes African American patients. Average doctor compliance (clinical quality) per patient is measured as the weighted average of all doctors who treated the patient during the period.



The following were used as cut-off points for doctor quality quintiles:

1. mean doctor quality$\leq$ 0.21
2. 0.21 < mean doctor quality $\leq$ 0.26
3. 0.26 < mean doctor quality $\leq$ 0.3
4. 0.3 < mean doctor quality $\leq$ 0.35
5. 0.35 < mean doctor quality

Table II: Patient adherence with therapy. Average yearly patient-specific adherence across all physicians. Standard errors are clustered at the clinic level.

Patients' average yearly adherence; all doctors, all medications				*Yearly adherence with ACEIs and BBs*
	(1)	(2)	(3)	(4)
Black	-0.024***	-0.023***	-0.036***	-0.058***
	(0.008)	(0.008)	(0.005)	(0.009)
Age	0.000	0.000	0.000***	0.001***
	(0.00)	(0.00)	(0.00)	(0.00)
Income		-0.001	-0.000	-0.002*
		(0.001)	(0.000)	(0.001)
Married		0.008***	0.006***	0.005
		(0.0018)	(0.0016)	(0.0037)
Co-morbidities	YES	YES	YES	YES
Cohort FE	YES	YES	YES	YES
Clinic FE	NO	NO	YES	YES
Constant	0.079***	0.076***	0.042***	0.486***
	(0.014)	(0.014)	(0.012)	(0.018)
Obs	43578	43578	43578	34928
R-squared	0.026	0.028	0.032	0.006

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; ***significant at 1%

Controls for co-morbidities include: old myocardial infarction, lymphoma, leukemia, pulmonary failure, diabetes, renal failure, colon cancer, angina, cardiomyopathy, ischemic heart disease, prostate cancer, liver disease, dysrhythmias, other cardiovascular disease, other cancers.

Table III: Patient adherence with therapy prescribed by individual physicians. Standard errors are clustered at the patient level.

Outcome: patient adherence doctors' decisions; all medications; patient-doctor pairs			
	(1)	(2)	(3)
Black	-0.037***	-0.038***	-0.056***
	(0.004)	(0.005)	(0.005)
Age	-0.000	-0.000	0.000***
	(0.000)	(0.000)	(0.000)
Income		-0.002***	-0.001**
		(0.001)	(0.001)
Married		0.000	0.002
		(0.003)	(0.002)
Co-morbidities	YES	YES	YES
Cohort FE	YES	YES	YES
Doctor FE	NO	NO	YES
Constant	14.811***	14.314***	12.391***
	(1.511)	(1.516)	(1.604)
Obs	121368	121368	121368
R-squared	0.004	0.004	0.005
Robust standard errors in parentheses			
* significant at 10%; ** significant at 5%; *** significant at 1%			

A patient-doctor pair is a match between a patient and a doctor which produces more than 2 prescriptions for the patient. Controls for co-morbidities include: old myocardial infarction, lymphoma, leukemia, pulmonary failure, diabetes, renal failure, colon cancer, angina, cardiomyopathy, ischemic heart disease, prostate cancer, liver disease, dysrhythmias, other cardiovascular disease, other cancers.

Table IV: Patient compliance with therapy. Patient-doctor pairs. The dependent variable is the ratio of compliant re-fills for every patient-doctor match. Column (1) shows compliance with all medications for the sub-sample of doctors who prescribed ACE inhibitors and beta blockers. Columns (2)-(4) have compliant with ACEIs and BBs as an outcome variable. Standard errors are clustered at the patient level.

Outcome: patient adherence with doctors; patient-doctor pairs; only clinically compliant physicians considered.				
	All medications	ACEIs-BBs	ACEIs-BBs	ACEIs-BBs
	(1)	(2)	(3)	(4)
Black	-0.062***	-0.041***	-0.042***	-0.064***
	(0.005)	(0.006)	(0.006)	(0.006)
Age	0.001***	0.000	0.000	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Income	-0.001**		-0.002***	-0.001**
	(0.001)		(0.001)	(0.001)
Married	0.003		0.002	0.003
	(0.003)		(0.003)	(0.003)
Co-morbidities	YES	YES	YES	YES
Cohort FE	YES	YES	YES	YES
Doctor FE	YES	NO	NO	YES
Constant	9.548***	17.130***	16.661***	13.292***
	(1.746)	(1.826)	(1.835)	(1.990)
Obs	76853	76853	76853	76853
R-squared	0.006	0.004	0.004	0.005
Robust standard errors in parentheses				
* significant at 10%; ** significant at 5%; *** significant at 1%				

A patient-doctor pair is a match between a patient and a doctor which produces more than 2 prescriptions for the patient. Controls for co-morbidities include: old myocardial infarction, lymphoma, leukemia, pulmonary failure, diabetes, renal failure, colon cancer, angina, cardiomyopathy, ischemic heart disease, prostate cancer, liver disease, dysrhythmias, other cardiovascular disease, other cancers.

Table V: Probability of being treated with recommended therapy of ACE inhibitors and beta blockers by a doctor. The unit of observation is the doctor-patient pair. Linear probability models. Controls for co-morbidities and year fixed effects included, coefficients not reported. Standard errors are clustered at the patient level.

Outcome: Probability of being treated with ACEIs and BBs; patient-doctor pairs			
	(1)	(2)	(3)
Black	-0.003	-0.009*	0.003
	(0.004)	(0.005)	(0.006)
Age		-0.003***	-0.003***
		(0.000)	(0.000)
Married		0.005*	0.002
		(0.0026)	(0.002)
Income		0.003***	0.001
		(0.000)	(0.0006)
Co-morbidites	YES	YES	YES
Cohort FE	YES	YES	YES
Doctor FE	NO	NO	YES
Obs	157469	157469	157469
R-squared	0.0116	0.029	0.027
Robust standard errors in parentheses			
* significant at 10%; ** significant at 5%; *** significant at 1%			

A patient-doctor pair is a match between a patient and a doctor which produces more than 2 prescriptions for the patient. Controls for co-morbidities include: old myocardial infarction, lymphoma, leukemia, pulmonary failure, diabetes, renal failure, colon cancer, angina, cardiomyopathy, ischemic heart disease, prostate cancer, liver disease, dysrhythmias, other cardiovascular disease, other cancers.

Table VI: Three-year survival probability conditional on two-year survival. Linear probability models. The dependent variable equals one if the patient survived the third year after diagnosis. All standard errors are adjusted for clinic-level clustering.

Outcome: Three year survival conditional on two year survival					
	(1)	(2)	(3)	(4)	(5)
Black	-0.022**	-0.017*	-0.019**	-0.018*	0.036
	(0.009)	(0.009)	(0.009)	(0.009)	(0.034)
Age	-0.005***	-0.005***	-0.005***	-0.005***	-0.005***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Income		0.002	0.002	0.002	0.002
		(0.002)	(0.002)	(0.002)	(0.002)
Married		0.029***	0.029***	0.026***	0.026***
		(0.007)	(0.007)	(0.007)	(0.007)
Doctor compliance with[ϒ]				0.375***	0.398***
guidelines				(0.051)	(0.052)
Black*doctor compliance					-0.193*
					(0.107)
Co-morbidities	YES	YES	YES	YES	YES
Cohort FE	YES	YES	YES	YES	YES
Clinic FE	NO	NO	YES	YES	YES
Constant	1.284***	1.251***	1.230***	1.127***	1.121***
	(0.026)	(0.021)	(0.037)	(0.041)	(0.041)
Observations	11463	11463	11463	11463	11463
R-squared	0.032	0.034	0.033	0.039	0.039
Robust standard errors in parentheses					
* significant at 10%; ** significant at 5%; *** significant at 1%					

Controls for co-morbidities include: old myocardial infarction, lymphoma, leukemia, pulmonary failure, diabetes, renal failure, colon cancer, angina, cardiomyopathy, ischemic heart disease, prostate cancer, liver disease, dysrhythmias, other cardiovascular disease, other cancers.

[ϒ]Mean doctor quality is defined as the mean clinical quality of providers encountered by the patient during the course of treatment

Figure 2: Effect of doctor quality on patient survival. The top line (red) indicates white patients. The lower line (in black) indicates African American patients. Doctor quality is measured as the weighted average of the individual adherence measures of all doctors who treated the patient during the period. Adherence to clinical guidelines is constructed as the N of patients who were prescribed ACEIs and beta blockers/ total N patients treated by the doctor. Large markers indicate significance of 80% and above.

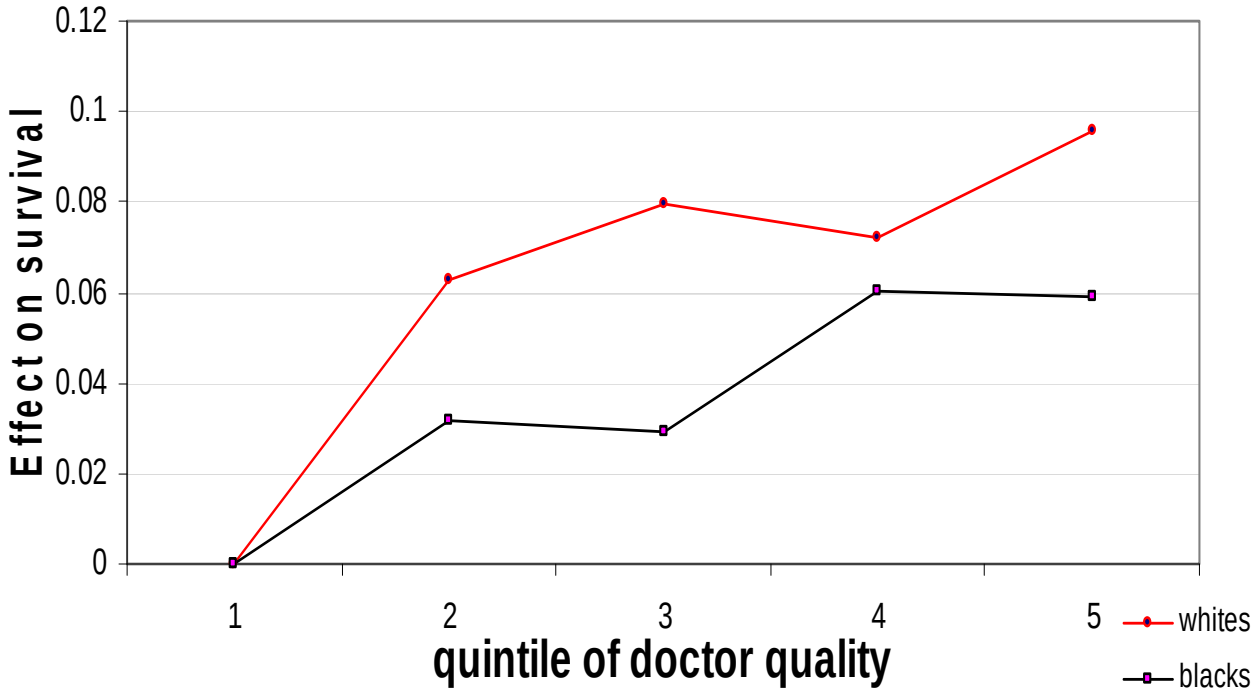


Table VII: Linear probability models estimating three-year survival conditional on two-year survival. All standard errors are adjusted for clinic-level clustering.

Outcome: Three year survival conditional on two year survival				
	(1)	(2)	(3)	(4)
Black	-0.018*	0.036	-0.019**	0.054
	(0.009)	(0.034)	(0.009)	(0.04)
Age	-0.005***	-0.005***	-0.005***	-0.005***
	(0.000)	(0.000)	(0.000)	(0.000)
Married	0.026***	0.026***	0.027***	0.028***
	(0.002)	(0.002)	(0.007)	(0.007)
Income	0.002	0.002	0.002	0.002
	(0.002)	(0.002)	(0.001)	(0.001)
Doctor compliance with[ץ]	0.375***	0.398***		
guidelines	(0.051)	(0.052)		
Black*doctor compliance		-0.193*		
		(0.107)		
First doctor compliance[ד]			0.37***	0.4***
			(0.046)	(0.048)
Black*first doctor				-0.21**
compliance				(0.11)
Constant	1.127***	1.121***	1.125***	1.12***
	(0.041)	(0.041)	(0.04)	(0.041)
Co-morbidities	YES	YES	YES	YES
Cohort FE	YES	YES	YES	YES
Clinic FE	YES	YES	YES	YES
Obs	11463	11463	11463	11463
R-squared	0.039	0.039	0.036	0.036
Robust standard errors in parentheses				
* significant at 10%; ** significant at 5%; * **significant at 1%				

Controls for co-morbidities include: old myocardial infarction, lymphoma, leukemia, pulmonary failure, diabetes, renal failure, colon cancer, angina, cardiomyopathy, ischemic heart disease, prostate cancer, liver disease, dysrhythmias, other cardiovascular disease, other cancers.

[ץ] Mean doctor quality is defined as the mean clinical quality of providers encountered by the patient during the course of treatment

[ד] First doctor quality is defined as the clinical quality of the first doctor from whom the patient obtained a prescription

Table VIII: The effect of adherence with therapy on survival. Linear probability models. Patient adherence is measured as adherence with therapy prescribed by the first treating physician. All standard errors are adjusted for clinic-level clustering.

Outcome: three year survival probability conditional on two-year survival			
	(1)	(2)	(3)
Black	-0.018*	-0.017*	-0.021**
	(0.009)	(0.009)	(0.009)
Age	-0.005***	-0.005***	-0.005***
	(0.000)	(0.000)	(0.000)
Income	0.002	0.002	0.002
	(0.002)	(0.002)	(0.002)
Married	0.026***	0.026***	0.026***
	(0.007)	(0.007)	(0.007)
Doctor compliance with[ɣ]	0.375***	0.378***	0.379***
guildelines	(0.051)	(0.051)	(0.051)
Full_adherence		0.018**	0.015*
		(0.008)	(0.009)
Black*Full_adherence			0.042
			(0.026)
Co-morbidities	YES	YES	YES
Cohort FE	YES	YES	YES
Clinic FE	YES	YES	YES
Constant	1.127***	1.124***	1.124***
	(0.041)	(0.041)	(0.041)
Observations	11463	11463	11463
R-squared	0.039	0.039	0.039
Robust standard errors in parentheses			
* significant at 10%; ** significant at 5%; *** significant at 1%			

Controls for co-morbidities include: old myocardial infarction, lymphoma, leukemia, pulmonary failure, diabetes, renal failure, colon cancer, angina, cardiomyopathy, ischemic heart disease, prostate cancer, liver disease, dysrhythmias, other cardiovascular disease, other cancers. Full compliance is a dummy indicating patient adherence of over 90%.

[ɣ] Mean doctor quality is defined as the mean clinical quality of providers encountered by the patient during the course of treatment

Table IX: The effect of physician clinical compliance on survival in (mostly) adherent and (mostly) nonadherent patients. Linear probability models. Patient adherence is measured as adherence with therapy prescribed by the first treating physician. All standard errors are adjusted for clinic-level clustering.

Outcome: Three year survival probability conditional on two-year survival						
	Mostly non-adherent patients (<50%)			Mostly adherent patients (>50%)		
	(1.1)	(1.2)	(1.3)	(2.1)	(2.2)	(2.3)
Black	-0.036**	-0.034**	0.057	-0.004	-0.005	0.006
	(0.014)	(0.014)	(0.048)	(0.016)	(0.017)	(0.045)
Age	-0.005***	-0.006***	-0.006***	-0.005***	-0.005***	-0.005***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Income	-0.000	-0.000	-0.000	0.003	0.003	0.003
	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)
Married	0.022**	0.020**	0.020**	0.037***	0.034***	0.034***
	(0.009)	(0.009)	(0.009)	(0.010)	(0.010)	(0.010)
Doctor compliance with[ɣ]		0.394***	0.447***		0.358***	0.361***
guidelines		(0.076)	(0.075)		(0.061)	(0.065)
Black*doctor compliance			-0.326**			-0.040
			(0.162)			(0.146)
Co-morbidities	YES	YES	YES	YES	YES	YES
Cohort FE	YES	YES	YES	YES	YES	YES
Clinic FE	YES	YES	YES	YES	YES	YES
Constant	1.239***	1.137***	1.123***	1.220***	1.121***	1.120***
	(0.045)	(0.050)	(0.051)	(0.048)	(0.052)	(0.052)
Obs	5194	5194	5194	6269	6269	6269
R-squared	0.035	0.041	0.042	0.036	0.042	0.042
Robust standard errors in parentheses						
* significant at 10%; ** significant at 5%; *** significant at 1%						

Controls for co-morbidities include: old myocardial infarction, lymphoma, leukemia, pulmonary failure, diabetes, renal failure, colon cancer, angina, cardiomyopathy, ischemic heart disease, prostate cancer, liver disease, dysrhythmias, other cardiovascular disease, other cancers. Full compliance is a dummy indicating patient adherence of over 90%.

[ɣ] Mean doctor quality is defined as the mean clinical quality of providers encountered by the patient during the course of treatment

Appendix A

Medical evidence on the progression and the pharmacological management of CHF

The progression of Chronic Heart Failure is divided into four stages depending on the extent of damage to the left ventricular ejection function of the heart muscle. Early diagnosis (within stages I or II) and subsequent therapy may prevent further deterioration of the heart function, and a patient's severity will not proceed to stages III or IV. Everyone in this study's analysis sample has CHF as a primary diagnosis, thus more likely to be at a later stage of development (such as III or IV).

Therapy guidelines

The American College of Cardiology guideline for CHF treatment published in 2005 states: "Beta-blockers are indicated in all patients without a recent history of MI (myocardial infarction) who have a reduced LVEF (left ventricular ejection function) with no HF symptoms. Angiotensin converting enzyme inhibitors should be used in patients with a reduced EF (ejection function) and no symptoms of HF, whether or not they have experienced MI…Angiotensin converting enzyme inhibitors are recommended for all patients with current or prior symptoms of HF and reduced LVEF, unless contraindicated".

In an overview of the clinical trials literature for the treatment of CHF, Bristow (2000) reports that "Based on combined evidence from a number of clinical trials, a combined ACEI and BB treatment is expected to decrease 1-year mortality by 46%". Silke (2006) concludes "In the major beta-blocker trials in CHF, a reduction in mortality of about 35% was consistently demonstrated with beta-blockade" and Senni et al (1998) show that the positive effects of ACEIs on survival do no abate with the progression of the disease. These estimates are in the vicinity of the ones obtained in the present study, with the effect of full doctor compliance with guidelines ranging between 30 and 40% reduction in mortality.

Relatively high levels of non-compliance with guidelines is not restricted to US physicians. For example, Murphy and co-authors (2004) found that in a cohort of Scottish patients with CHF, ACEIs were prescribed to 39% and beta blockers to 21% of the group.

Mortality patterns

Levy and co-authors (2002) report 18% mortality rate within the first year in men surviving 30 days after an index hospitalization, and 54% mortality in a 5-year period. McCullough et al (2002) report similar findings of the one- and two-year survival rates, with the survival curve flattening in the years after. Both of these studies report mortality rates in the same ballpark as the ones found in the sample presented here.

Croft et al (1999) find much higher mortality rates, in excess of 30% in the first year after diagnosis. They also report a flattening of the survival curve in later years, suggesting that the most infirm patients at the onset perish first. Senni et al (1998) find 23% combined 3-year mortality among those treated with ACEIs and 26% among those who were given a placebo. They also observe higher mortality rates in the first two years of follow-up.

Appendix B
Patient adherence to therapy

In an overview of the available measures and evidence for patient adherence to medication therapy, Ostenberg and Blaschke (2005) conclude that "rates of refilling prescriptions are an accurate measure of overall adherence in a closed pharmacy system (e.g., health maintenance organizations, the Department of Veterans Affairs Health Care System, or countries with universal drug coverage), provided that the refills are measured at several points in time. A medical system that uses electronic medical records and a closed pharmacy can provide the clinician or research scientist with readily available objective information on rates of refilling prescriptions that can be used to assess whether a patient is adhering to the regimen and to corroborate the patient's responses to direct questions or on questionnaires."

The effect of poor adherence on hospitalizations and costs is high "Of all medication-related hospital admissions in the United States, 33 to 69 percent are due to poor medication adherence, with a resultant cost of approximately $100 billion a year. Participants in clinical trials who do not follow medication regimens or placebo regimens have a poorer prognosis than subjects in the respective groups who do. Adherence to medication and placebo regimens, therefore, both predict better outcomes, and collecting adherence data from subjects is now considered an essential part of clinical trials. Given the magnitude and importance of poor adherence to medication regimens, the World Health Organization has published an evidence-based guide for clinicians, health care managers, and policymakers to improve strategies of medication adherence." (Ostenberg and Blaschke, 2005)

Appendix C

Means comparisons between compliant and non-compliant patients

Table C.1: Observable characteristics of compliant and non-compliant patients by race for the sample of patients who survived two years after diagnosis.

Variable	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*difference*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*difference*
			Compliant					Non-compliant		
Income	22930	16900	17450	9080	5480	23250	16630	17710	9460	5540
Married	0.669	0.470	0.474	0.500	0.195	0.703	0.457	0.501	0.500	0.202
Age	70.89	9.413	67.19	11.37	3.7	71.47	9.27	65.31	11.43	6.16
Colon cancer	0.008	0.091	0.013	0.112	-0.005	0.008	0.089	0.009	0.092	-0.001
Old AMI	0.049	0.217	0.046	0.210	0.003	0.057	0.232	0.063	0.243	-0.006
Angina	0.047	0.211	0.046	0.210	0.001	0.060	0.238	0.067	0.250	-0.007
Hernia	0.025	0.157	0.041	0.198	-0.016	0.025	0.155	0.016	0.124	0.009
Pulmonary disorders	0.318	0.466	0.260	0.439	0.058	0.287	0.452	0.270	0.444	0.017
Lymphoma	0.001	0.036	0.000	0.000	0.001	0.002	0.039	0.003	0.053	-0.001
Leukemia	0.013	0.114	0.023	0.150	-0.01	0.015	0.122	0.016	0.124	-0.001
Other cancers	0.055	0.228	0.071	0.258	-0.016	0.055	0.229	0.059	0.235	-0.004
Prostate Cancer	0.060	0.237	0.059	0.235	0.001	0.059	0.236	0.073	0.260	-0.014
Skin/bone cancer	0.010	0.102	0.015	0.123	-0.005	0.012	0.108	0.001	0.038	0.011
Liver disorders	0.031	0.174	0.033	0.179	-0.002	0.029	0.168	0.031	0.175	-0.002
Renal disorders	0.143	0.350	0.161	0.368	-0.018	0.134	0.341	0.154	0.361	-0.02
Diabetes	0.374	0.484	0.406	0.492	-0.032	0.356	0.479	0.367	0.482	-0.011
Other Cardiovascular	0.106	0.308	0.133	0.340	-0.027	0.100	0.300	0.107	0.310	-0.007
Dysrhythmias	0.282	0.450	0.173	0.379	0.109	0.292	0.455	0.200	0.400	0.092
Cardiomyopathy	0.074	0.261	0.125	0.331	-0.051	0.077	0.267	0.130	0.337	-0.053
Ischemic heart disease	0.539	0.499	0.398	0.490	0.141	0.544	0.498	0.453	0.498	0.091
Cohort	1999	0.681	1999	0.662		1999	0.674		1999	0.692
Obs	6044		392			4639			700	

Veterans vs. non-veterans and selection into VHA

These tables provide comparisons between veterans and non-veterans and between VHA-users and non-users based on data from the 2000 March CPS and the 2000 National Survey of Veterans

Table C.2 Differences in education and marital status between veterans and non-veterans

	All CPS	*Over 65*	*All CPS*	*Over 65*	*All CPS*	*Over 65*
	Education in years		*Married*		*Income in $*	
Black	-0.921***	-2.681***	-0.196***	-0.175***	-4759***	-2685***
	(0.052)	(0.215)	(0.009)	(0.028)	(361)	(721)
Veteran	0.255***	1.142***	0.167***	0.024**	8407***	10645***
	(0.032)	(0.082)	(0.005)	(0.011)	(324)	(413)
Black*Veteran	0.397***	0.945***	0.032	-0.023	-813	-1494
	(0.117)	(0.310)	(0.020)	(0.041)	(1109)	(1604)
Constant	9.947***	8.642***	0.581***	0.745***	23258***	9070
	(0.015)	(0.065)	(0.003)	(0.008)	(112)	(217)
Observations	48747	7422	48747	7422	48747	7422
R-squared	0.009	0.062	0.033	0.012	0.01	0.04
Standard errors in parentheses						
* significant at 10%; ** significant at 5%; ***significant at 1%						

Table C.3 Probability of using VHA among veterans; OLS linear probability models

	All veterans	*Veterans on Medicare*	*Veterans with a heart condition*	*Veterans on Medicare with a heart condition*
Black	0.061	0.031	0.086	0.166
	(0.043)	(0.062)	(0.098)	(0.120)
Education	-0.081***	-0.081***	-0.086***	-0.087***
	(0.004)	(0.005)	(0.008)	(0.009)
Income (in '000 $)	-0.012***	-0.011***	-0.011***	-0.007***
	(0.001)	(0.002)	(0.002)	(0.003)
Married	-0.131***	-0.082***	-0.112***	-0.072***
	(0.009)	(0.014)	(0.020)	(0.024)
Black*married	-0.026	0.003	0.011	-0.029
	(0.027)	(0.045)	(0.063)	(0.084)
Black*educ	0.039***	0.039*	0.041	0.027
	(0.014)	(0.022)	(0.031)	(0.039)
Black*income	-0.002	0.002	-0.007	-0.010
	(0.004)	(0.006)	(0.008)	(0.010)
Constant	0.734***	0.742***	0.837***	0.803***
	(0.014)	(0.019)	(0.028)	(0.033)
Observations	15159	7398	3614	2518
R-squared	0.071	0.057	0.062	0.052
Standard errors in parentheses				
*significant at 10%; ** significant at 5%; *** significant at 1%				