

An analysis of Medicare Provider Utilization and Payment Data:
A focus on the top 5 DRGs and mental healthcare

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Introduction

In an effort to increase transparency and accountability in the US Health System, the Obama administration mandated the Center for Medicare Services (CMS) to make available data for use by researchers and interested parties from the general public. Among the more well-known uses of this data are analyses published by the Wall Street journal showing that a large, and in some cases, shocking discrepancy between what hospitals potentially charge the uninsured and what they are paid by Medicare for the same procedure. Analyses such as these highlight both potential inequities in the US health system and, more importantly, potential opportunities for its reform. However, while capturing the public imagination, analyses such as these are but one means to capitalize on the remarkable wealth of information these data provide. Specifically, data from the public distribution CMS data can help both researchers and the public better understand the burden specific conditions and medical treatments place on the US Health System. It was this simple, but important objective that motivated the present study.

Our specific analyses focus on two of what we believe to be important questions. First, using the total number of hospital discharges as a proxy for incidence of a condition or treatment, which have the highest incidence rates nationally? Does their incidence remain stable, or is it increasing/decreasing? And, is there variability in these incidence rates across states? Second, as psychologists, we are necessarily interested in understanding the state of mental healthcare. To date, and to the best of our knowledge, there has been no study utilizing the public ‘inpatient Medicare provider utilization and payment’ dataset¹ to explore the utilization of mental illness services funded by Medicare. A second set of analyses focuses on describing the standing of Medicare expenditure on mental illness services as compared to other diagnoses, followed by a description different groups of mental health providers.

Methods & Data

The present study utilizes ‘Medicare Provider Utilization and Payment Data: Inpatient’ and is made publicly available by the Centers for Medicare and Medicaid Services⁶. The dataset was loaded into a Hadoop database, accessed via Amazon Workspaces, and within that environment, SAS Studio 3.4 (Enterprise Edition) was used to perform all analyses.

The original dataset contains data on 100 procedures insured by Medicare and provided by more than 3,000 US hospitals. These data are made publicly available by the Centers for Medicare and Medicaid Services⁶. Procedures were treated as within the top 100 if the total number of discharges billed to Medicare for a given procedure was ranked in the top 100 nationally for a given reporting year. Inpatient discharges in this dataset are restricted to short term hospitalization where procedures are performed in the hospital after admission. These data represents approximately 60% of the total inpatient discharges funded by Medicare nationally.

The dataset contains 12 variables, 8 of which describe the DRG and hospital demographics (see Figure1 in Appendix A for an overview). The remaining 4 variables provide information on total discharges and information related to payments for a given DRG. The data spans three years starting from 2011 to 2013. Table1 in the appendix B provides detailed descriptions of these variables. The dataset is made available in a structured format where each column denotes a separate variable and each row a separate observation. The data itself is hierarchy nature such that top 100 DRGs are nested within hospitals, hospitals within HRRs or cities, and cities within states (see Figure2 in Appendix A).

Before starting analysis, the dataset was cleaned and validated by:

- 1) inspecting all variables to ensure that each field contains only the appropriate variable type;
 - a. e.g. categorical or continuous
- 2) along with the appropriate values;
 - a. e.g. zip code variable has only 5 numbers, and
 - b. in the case of character variables such as a hospital's state, health reporting region, city, or in the case of DRG's, the DRG description, a list of all their values within each of the datasets were obtained and then checked whether any of these has been truncated when converting raw data to SAS format. SAS routines used to load these data were amended as necessary.
- 3) with no missing values;
- 4) and last but not least, all continuous variables containing information on total discharges, average medicare payment, average total payment (medicare and deductibles/copays), and what a hospital bills medicare were screened for outliers as follows:
 - a. First, the minimum, maximum for each variable were obtained followed by a screening for odd values such as negative, or unusually high values (e.g. a million).
 - b. Subsequently, values for the top and bottom 1% by DRG and ignoring hospitals were considered.
 - c. Potential outliers identified as extreme values within these ranges using boxplots and were flagged for further investigation.
 - d. No outliers at the most granular level of the dataset (i.e., DRG within hospital) were identified using these methods.

Analysis, Results & Conclusion

Top 5 DRGs:

In many instances, multiple DRGs are used to bill for treatment of the same condition. In these cases, DRGs are differentiated from one another on the basis of whether treatment of the condition was more expensive due to accompanying medical complications. To gain a better understanding of the burden placed on the Medicare system by a given condition, DRGs were first grouped by treatment condition and then total discharges and total Medicare payments for each DRG by hospital were calculated. Total discharges by hospital were calculated as the sum of discharges for all DRGs within the group. Total Medicare payments for each DRG group by hospital were calculated as follows:

- 1) First calculate the total Medicare payment for each DRG as the total discharges for the DRG multiplied by its average Medicare payment.
- 2) Then sum total payments by DRG group, resulting in the total Medicare payment for each DRG group by hospital.
- 3) Total discharges and total payments per DRG group by hospital were then used in all subsequent analyses.

Maps:

For each DRG group analysed, total discharges were first summed by state. Using projections of state populations from the 2010 US census for 2011 and 2013², we then calculated the total discharges per 10,000. Subsequently, the 10th, 25th, 50th, 75th and 90th percentile were obtained for these state level measures. Color-coded choropleth maps were then produced showing where in the possible range of values a given state fell, with very low defined as the 10th percentile or below, low as the 11th to the 25th percentile, low moderate as the 26th to 50th percentile, high moderate as the 51st to the 75th percentile, high as the 76th to the 90th percentile, and very high as greater than the 90th percentile.

The compound rate of growth over the period 2011 to 2013 for discharges per 10,000 per DRG by state was calculated. Choropleth maps showing these rates of change by state were also produced. Here color coding varied by DRG where necessary to differentiate states where the “incidence” rate was increasing from those where the “incidence” rate was decreasing.

Table 2 in appendix B shows the five DRG groups that, in 2011, were associated with the highest number of total discharges nationally. Table 2 also shows total national expenditures, total national discharges, average Medicare payment per procedure (calculated as the total expenditure nationally divided by the total number of discharges nationally), and rates of discharge per 10K for these five procedures in 2011 and 2013. Percentage change 2013 over 2011 for each of these metrics is also shown. We immediately note that, with the exception of Septicemia/Sepsis and Major Joint Replacements (Lower Extremities), total expenditures as well as total discharges are down nationally 2013 over 2011 for each of these DRGs. Further note, expenditures and average

Medicare payments related to the treatment of Septicemia/Sepsis are the highest of the five DRGs. In fact, expenditures for Septicemia/Sepsis are more than double those for both COPD (Chronic Obstructive Pulmonary Disorder) and Pneumonia in 2011, and double those for both these conditions as well as Heart Failure and Shock in 2013. Average Medicare payments for Septicemia/Sepsis are also highest in both 2011 and 2013 and almost double those for both COPD and Pneumonia in both years. Clearly, Septicemia/Sepsis is a concern both in terms of its incidence rate but also in terms of its monetary burden on the National Health System. We correspondingly focus our national level analysis on this condition.

In August of 2015, the CDC declared September to be “SEPTicemia” month³ in an attempt to draw public attention to what, if left unchecked, is likely to become, if it is not already, a major public health crisis. Historically, septcemia/sepsis was called “blood poisoning” a particularly apt description given that the condition arises due the spread of a localized infection throughout the rest of the body. Septcemia/sepsis kills and is expensive to treat as treatment must often been administered in a hospital’s intensive care unit⁴. These high treatment costs likely account for the condition’s relatively high average expenditure rating, as shown in Table 2. The elderly, who represent the largest proportion of those insured under Medicare, are particularly susceptible to the condition⁵. Examples of conditions leading to septicemia - and to which the elderly are particularly susceptible - include unchecked urinary tract infections, skin infections, pneumonia, and the flu (*ibid.*). Septicemia/Sepsis is a preventable disease (*ibid.*).

As shown in Appendix C, Figure 13, the 2011 hospitalization rate per 10K for those with a primary diagnosis of septicemia was highest for states east of the Mississippi, while those for states west of the Mississippi were among the lowest nationwide. However, as again shown in Appendix C, Figure 13 this pattern is reversed when considering 2011-2013 rate of compound growth in rate of hospitalization per 10K. Here rates of compound growth in hospitalization rates per 10K among those with a primary diagnosis of septicemia tended to be highest in states west of the Mississippi while those for states east of the Mississippi tended to be among the lowest. A notable exception is Texas, where rates of compound change in the per 10K hospitalization rate was among the lowest nationwide. The reader’s attention is also drawn to rates of compound growth in the per 10K septicemia hospitalization rate for states such as Massachusetts and Virginia. In both cases, rates of hospitalization per 10K are already high by national standards and the compound change in these rates is in the top 50 to 75% nationally.

Mental Illness DRG:

According to the National Alliance on Mental Illness (NAMI), approximately 1 in 5 adults (18.5% or 43.8million adults) in the USA experience some form of mental illness in a given year⁶. Of that, approximately 15% are adults that are 50 years of age or older⁷. Since the majority of Medicare recipients are adults age 65 and over, most if not all of the utilization of Medicare mental illness services will be by seniors. Mental illness is complex and has a high economic and human cost. Furthermore, these costs are likely more pronounced for people with lower

incomes⁸. Seniors generally have a lower income when compared with younger adults. For example, one estimate of the median annual income of seniors in 2014 is 22,248 dollars⁹, which is approximately half the per capita personal income of 46,129 dollars for the US in 2014¹⁰. This potentially puts seniors at a higher risk for hardship when experiencing mental illness. Thus it is imperative to get a good understanding of Medicare provider utilization in the context of mental illness diagnoses.

To better understand Medicare expenditures on mental illness services, DRGs were grouped into their respective MDC categories¹¹. The only mental illness diagnosis that is included in the top 100 DRGs is ‘885 psychoses’. Consequently this is the only DRG included in the MDC 19 category.

Figure 3 in appendix A shows the relationship between total Medicare payments and the total average amount charge by providers (TotalMSRP) at the national level across all three years. These total average charges were calculated by multiplying the provider’s average charge for each DRG by the corresponding number of discharges billed. Both total Medicare payments and the total average charges for all providers were both relatively low for MDC 19, putting it at 11th place nationally for both measures in all three years.

In the terms of the ratio of TotalMSRP to total Medicare expenditures, MDC 19 is the lowest among all MDCs in all three years (see Figure 4 in appendix A). This implies that the difference between Medicare compensation and TotalMSRP is relatively small for mental illness services. Across all three years, the median ratio of TotalMSRP to Medicare payments for MCD 19 was 3.08. Thus, on average providers charge 3 times what Medicare pays for mental illness services (i.e. psychosis).

Figure 5 in appendix A shows the relationship between total Medicare payments and potential ‘out of pocket’ costs for patients (TotalDifference) at the national level. Potential out of pocket costs was calculated by taking the difference between the average total payments received by providers and the total average payments Medicare make to providers (see table 1 for definition for average total payment). Both total Medicare payments and the potential ‘out of pocket’ costs for patients were relatively low for MDC 19, again putting it at 11th place nationally for both measures in all three years. In terms of ratio of Medicare payments to potential out of pocket costs, MDC 19 is the second lowest among all MDCs in all three years (see Figure 6 in appendix A). Across all three years, the median ratio of Medicare payments to potential out of pocket costs for MDC 19 is 0.18. In other words, for every dollar Medicare spends on mental illness services, the potential out of pocket cost for the patient is 0.18 dollars.

Figures 4 and 6 show some variability among in the distribution of the ratios. To further explore the underlying structure of the variability and to further understand the utilization of Medicare

mental illness services, a cluster analysis (Hierarchical cluster analysis, Ward's method) was performed in an attempt to tease out the potential groups of mental illness providers. Individual states were grouped into their respective regions¹², enabling additional analysis of the mental illness providers by region. Within MDC19, scatterplot matrices of the ratio of MSRP to Medicare payments, potential out of pocket costs, and total discharges by geographical region for years 2011, 2012 and 2013 (Figures 7,8,9 in appendix A) show that there is no natural clustering in the type of available mental illness providers by geographical region or state. Using cluster analysis, we seem to uncover 3 types of mental illness providers (Figures 10,11,12 in appendix A):

- 1) The first group of providers had a profile that is relatively high on the rates of discharges, but is average when it comes to the ratio of provider's average charge to Medicare payments and potential out of pocket costs to patients.
- 2) The second group of providers had a profile that is relatively high on the potential out of pocket costs to patients, but the rate of discharge is low. This group has an approximately average profile in the ratio of provider's average charge to Medicare payments.
- 3) The third group of providers on the other hand had a profile that is relatively low in potential out of pocket costs and rate of discharges. This group also has an approximately average profile in the ratio of provider's average charge to Medicare payments.

The types of mental illness provider groups seem to hold over the three years. However the membership of mental illness providers may differ (see Table 3 in appendix B).

Future directions

The current study explored the top five DRGs with the highest incidence rates in addition to Medicare expenditure on mental illness services using the 'Medicare Provider Utilization and Payment Data: Inpatient' public dataset.

There are several limitations of the present study that should be addressed in future studies. First, the public dataset is inherently incomplete. For example, it only contains the top 100 DRGs and the inpatient discharges in this dataset are restricted to short term hospitalization. Future studies should use the complete dataset in order to arrive at a more comprehensive picture of Medicare Provider Utilization. Further research may also explore other DRGs of interest.

Second, the present exploratory analysis revealed considerable variability on rate of discharges within hospitals by state. Future studies should obtain population level data at the level of the state or HRR in order to further explore the variability.

We are thankful to SAS Student Symposium 2016 for the opportunity to explore this dataset with SAS Studio.

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References

- 1 <https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/Medicare-Provider-Charge-Data/Inpatient.html>
- 2 <http://www.census.gov/popest/data/national/totals/2015/index.html>
- 3 <https://www.youtube.com/watch?v=mgTQLTjrTqA&feature=youtu.be>
- 4 <http://www.cdc.gov/nchs/data/databriefs/db62.htm>
- 5 <http://www.cdc.gov/sepsis/basic/qa.html>
- 6 <https://www.nami.org/Learn-More/Mental-Health-By-the-Numbers>
- 7 <http://www.samhsa.gov/data/sites/default/files/NSDUH-FRR1-2014/NSDUH-FRR1-2014.htm#idtextanchor073>
- 8 <http://www.scientificamerican.com/article/a-neglect-of-mental-illness/>
- 9 <http://www.pensionrights.org/publications/statistic/income-today%20%99s-older-adults>
- 10 <http://www.ofm.wa.gov/trends/economy/fig101.asp>
- 11 <http://www.cheatography.com/davidpol/cheat-sheets/major-diagnostic-category-mdc-to-ms-drg-mapping/>
- 12 <http://www.mapsofworld.com/usa/usa-maps/united-states-regional-maps.html>

Appendix A

Figure 1: Variable type and variable name.

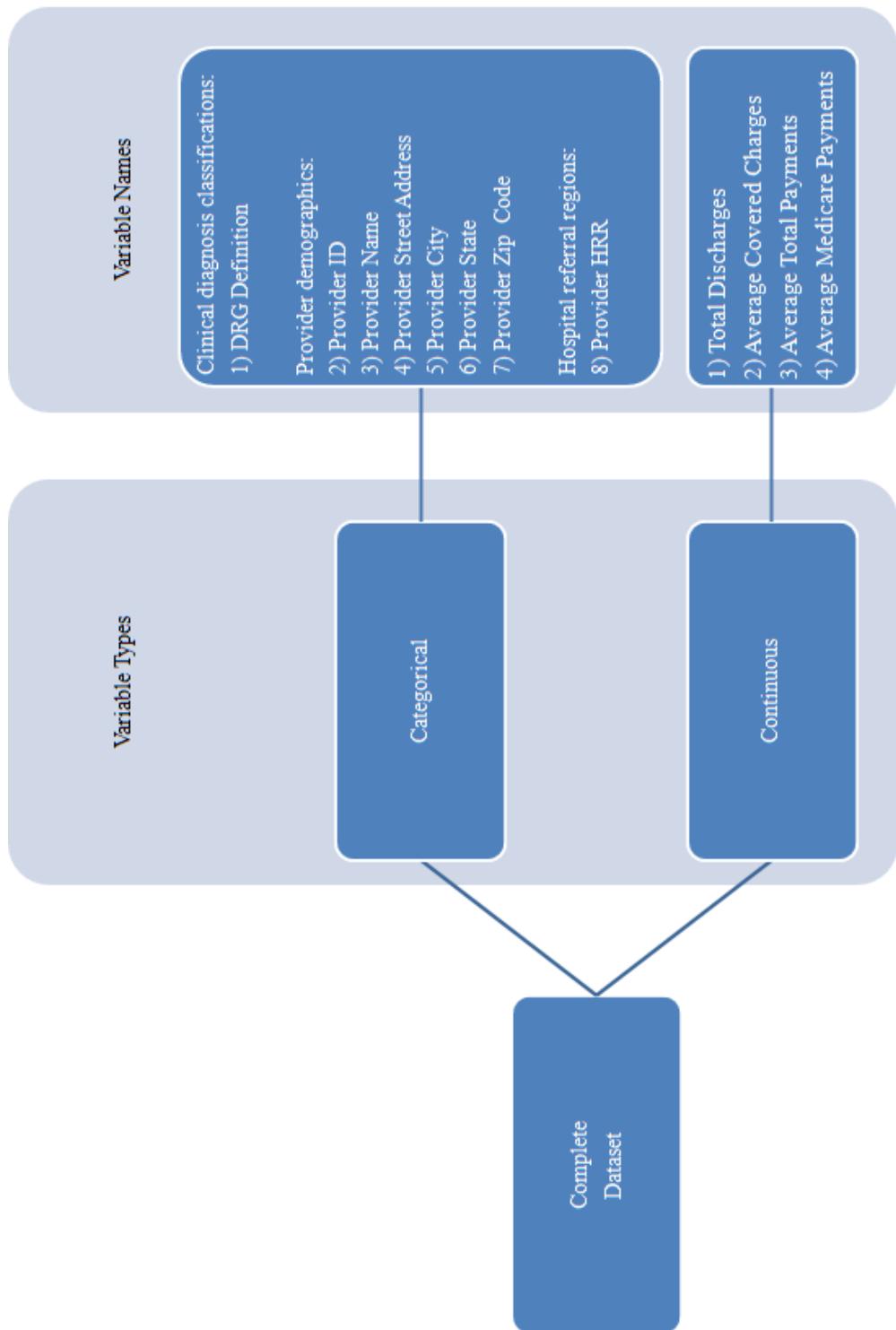


Figure 2: Hierarchy of variables in the dataset for each year.

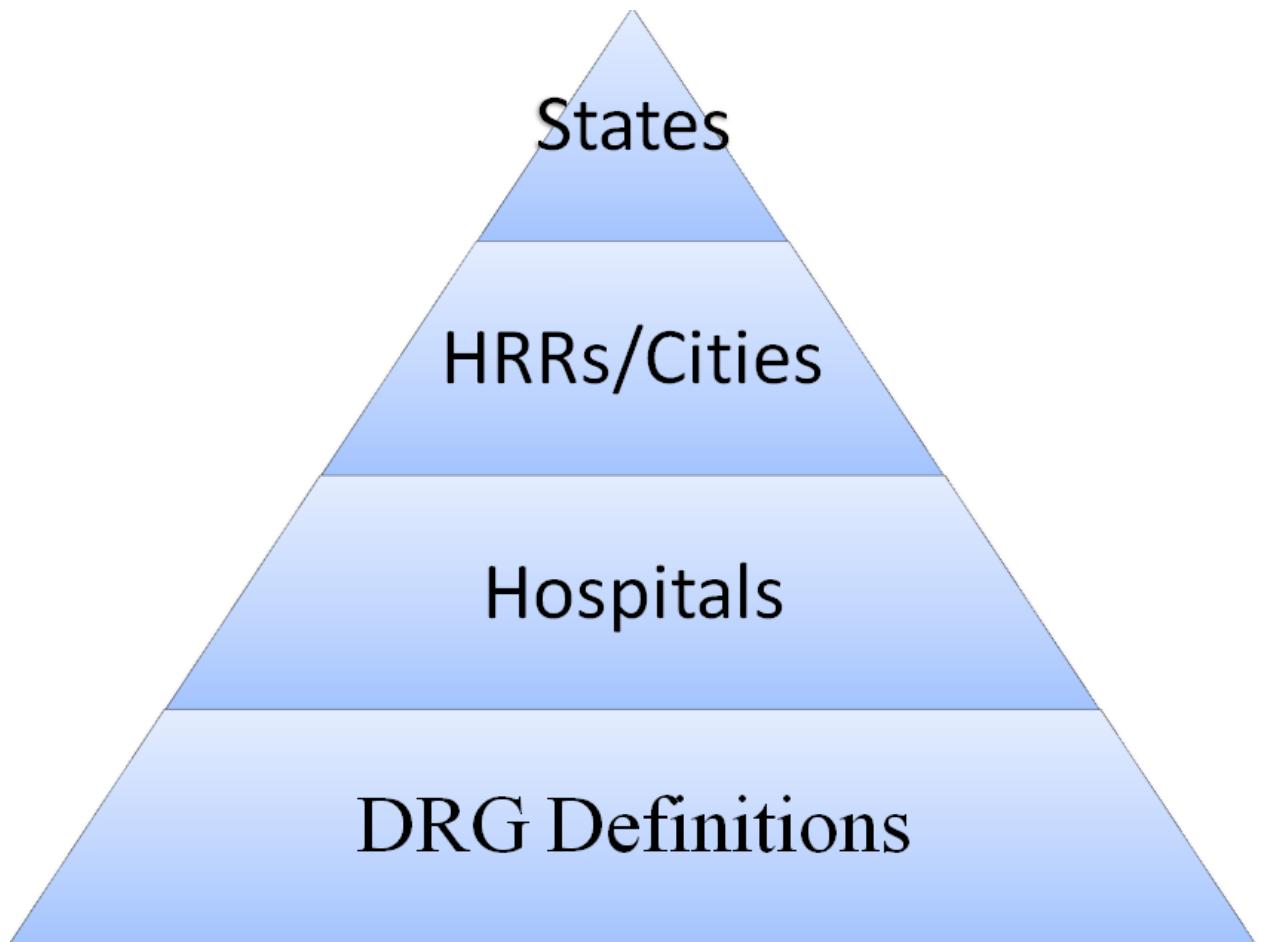
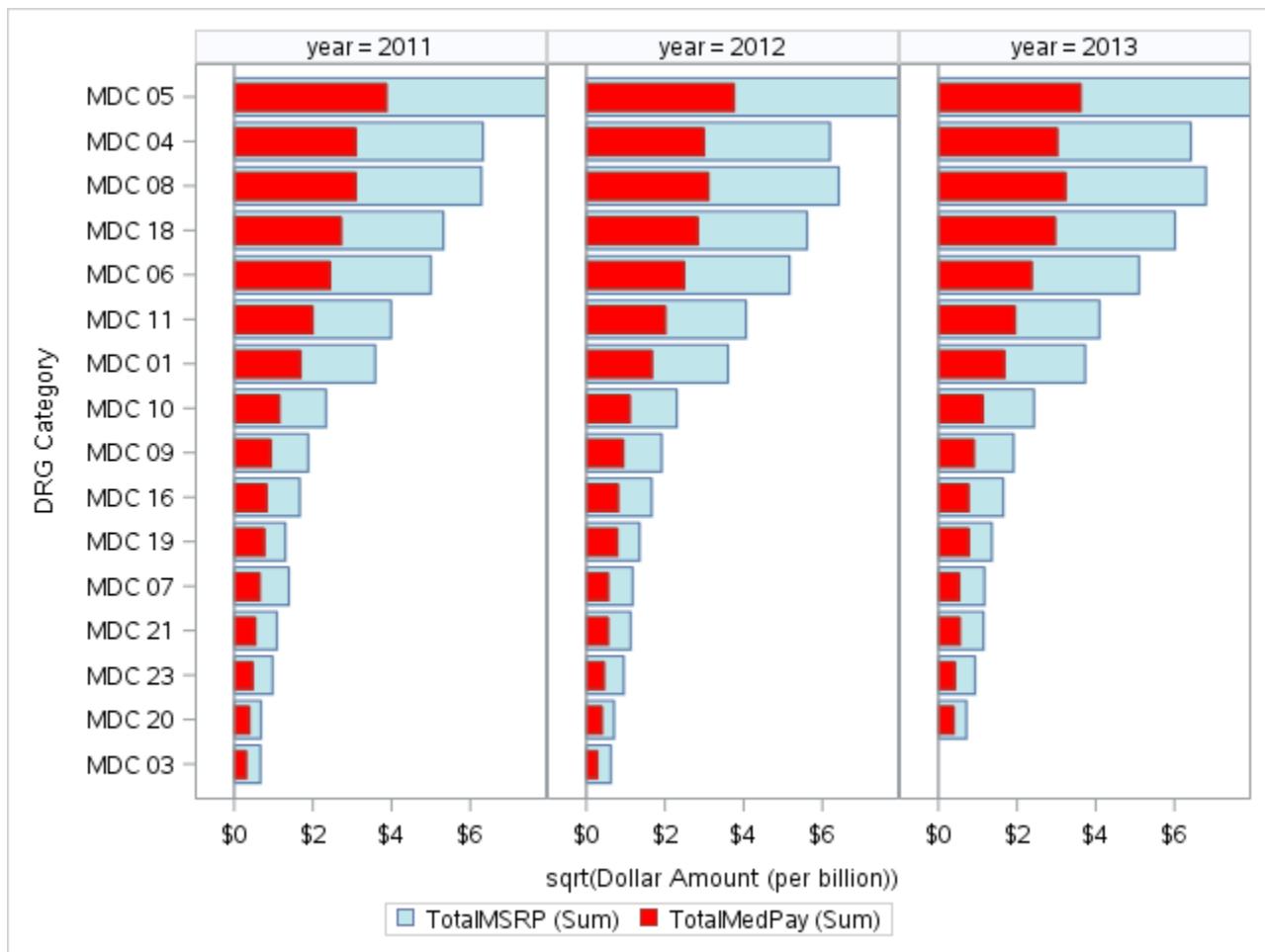


Figure 3: Medicare expenditure vs. TotalMSRP on mental illness as compared to all other DRGs.



MDC Legend

MDC 05: DISEASES & DISORDERS OF THE CIRCULATORY

MDC 04: DISEASES & DISORDERS OF THE RESPIRATORY

MDC 08: DISEASES & DISORDERS OF THE MUSCULOSKELETAL

MDC 18: INFECTIOUS & PARASITIC DISEASES

MDC 06: DISEASES & DISORDERS OF THE DIGESTIVE SYSTEM

MDC 11: DISEASES & DISORDERS OF THE KIDNEY & URINA

MDC 01: DISEASES & DISORDERS OF THE NERVOUS SYSTEM

MDC 10: ENDOCRINE, NUTRITIONAL & METABOLIC DISEASE

MDC 09: DISEASES & DISORDERS OF THE SKIN, SUBCUTAN

MDC 16: DISEASES & DISORDERS OF BLOOD

MDC 19: MENTAL DISEASES & DISORDERS

MDC 07: DISEASES & DISORDERS OF THE HEPATOBILIARY

MDC 21: INJURIES, POISONINGS & TOXIC EFFECTS

MDC 23: FACTORS INFLUENCING HLTH STAT & OTHR CONTAGENT

MDC 20: ALCOHOL/DRUG USE & ALCOHOL/DRUG INDUCED

MDC 03: DISEASES & DISORDERS OF THE EAR, NOSE, MOUTH

Figure 4: Ratio of TotalMSRP and Medicare expenditure on mental illness as compared to all other DRGs.

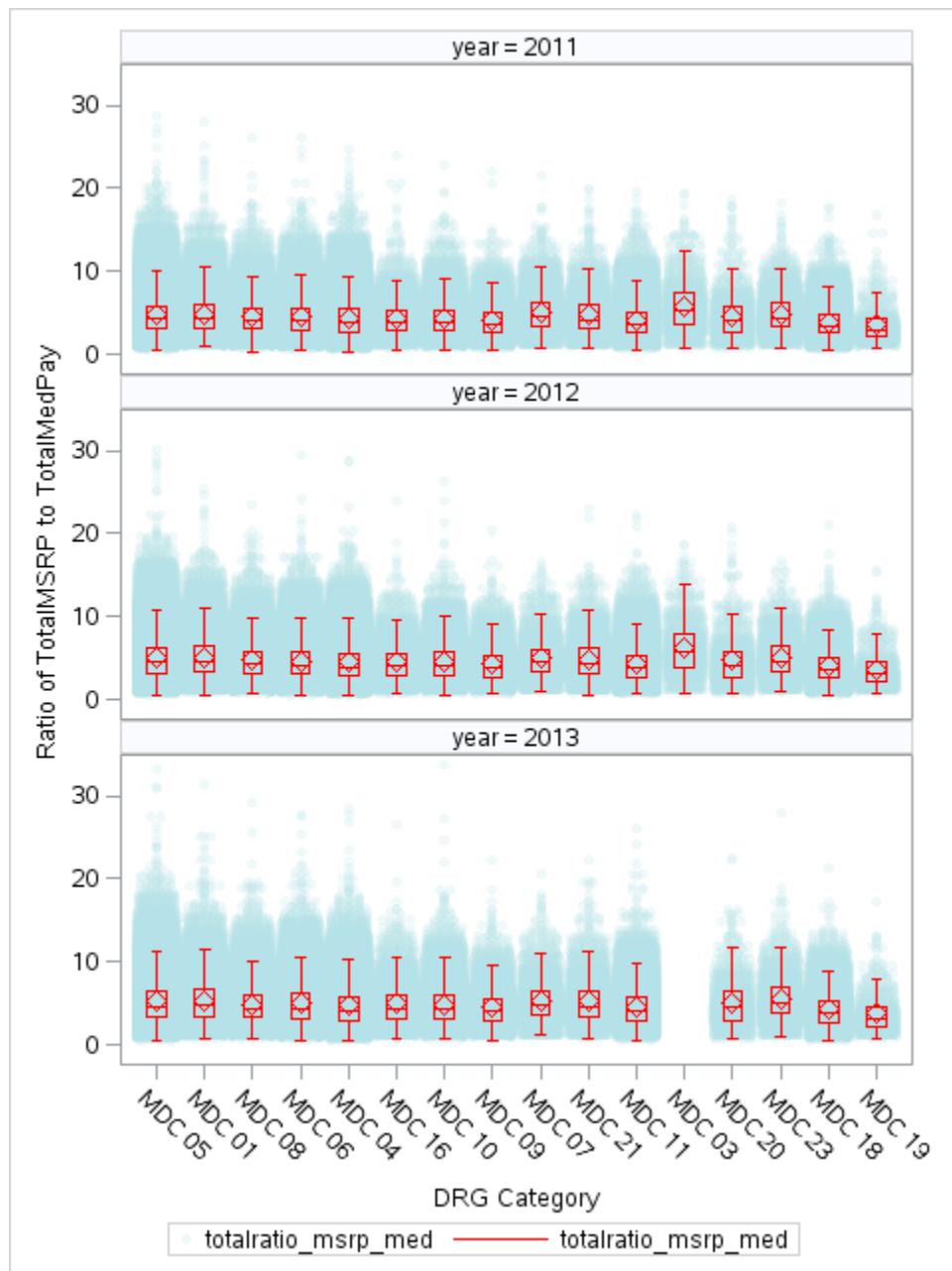


Figure 5: Medicare expenditure vs. potential out of pocket cost on mental illness as compared to all other DRGs.

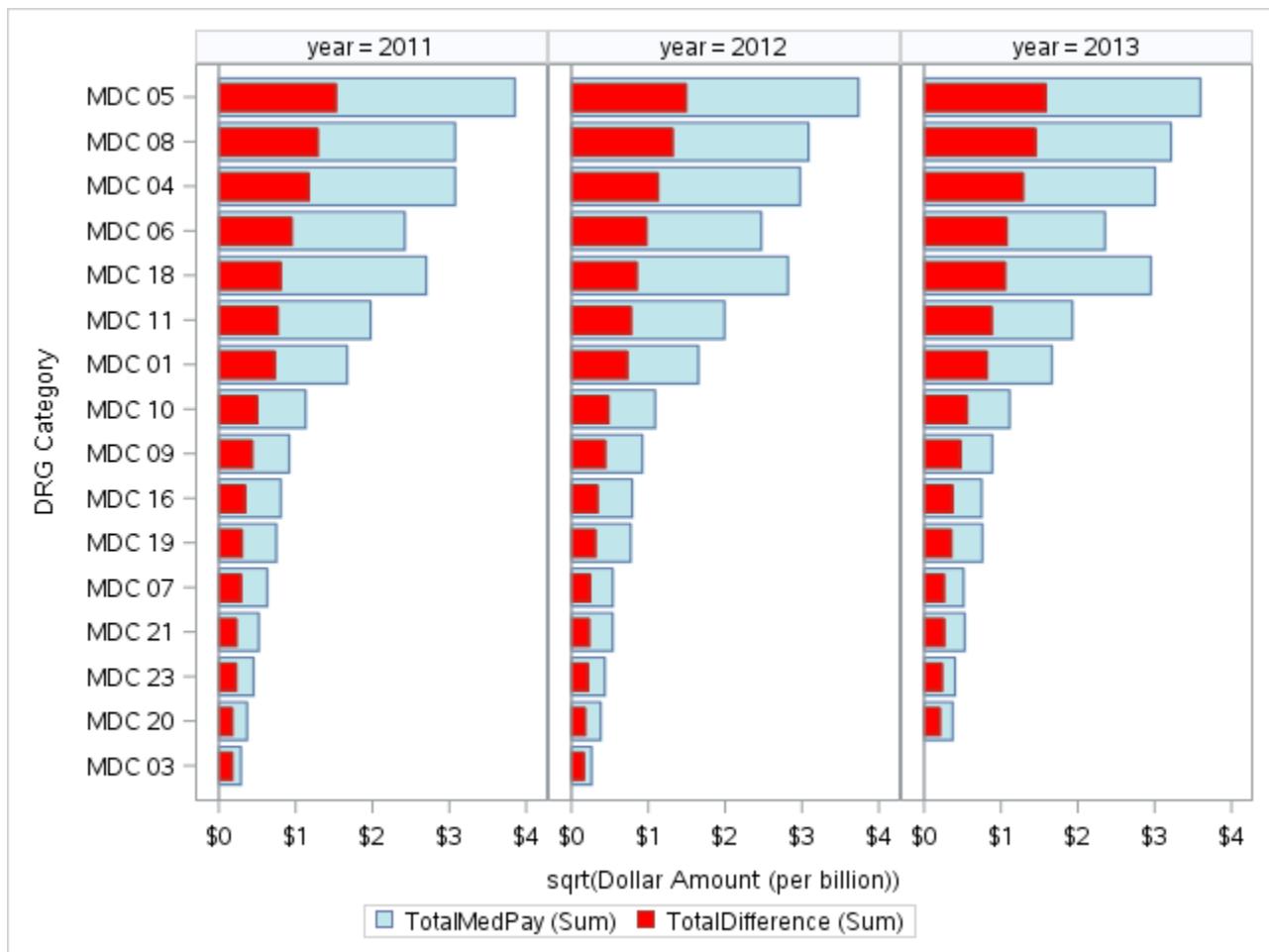


Figure 6: Ratio of Medicare expenditure and potential out of pocket costs on mental illness as compared to all other DRGs.

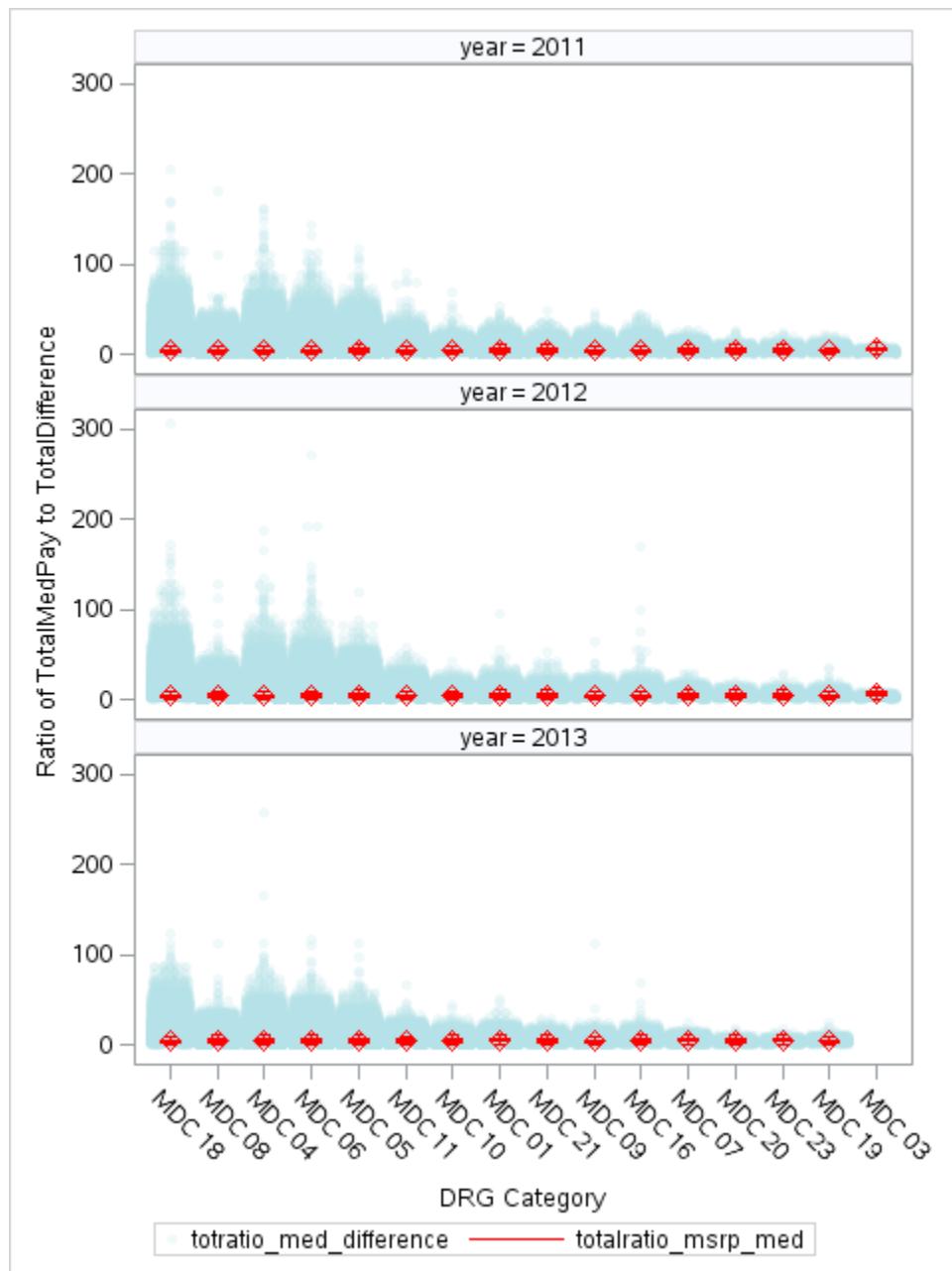
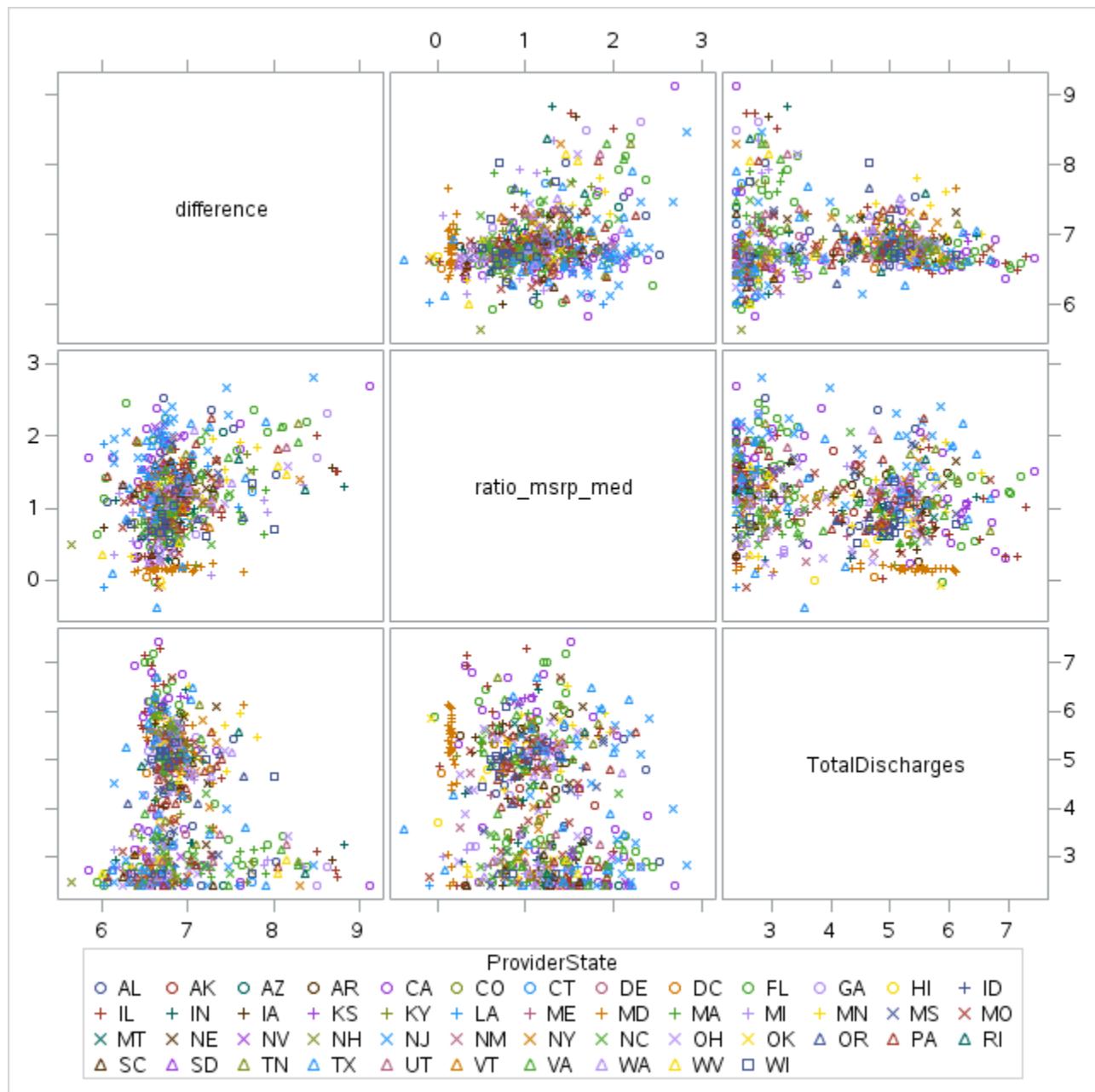


Figure 7: Scatterplot matrix by state and region, for year 2011.



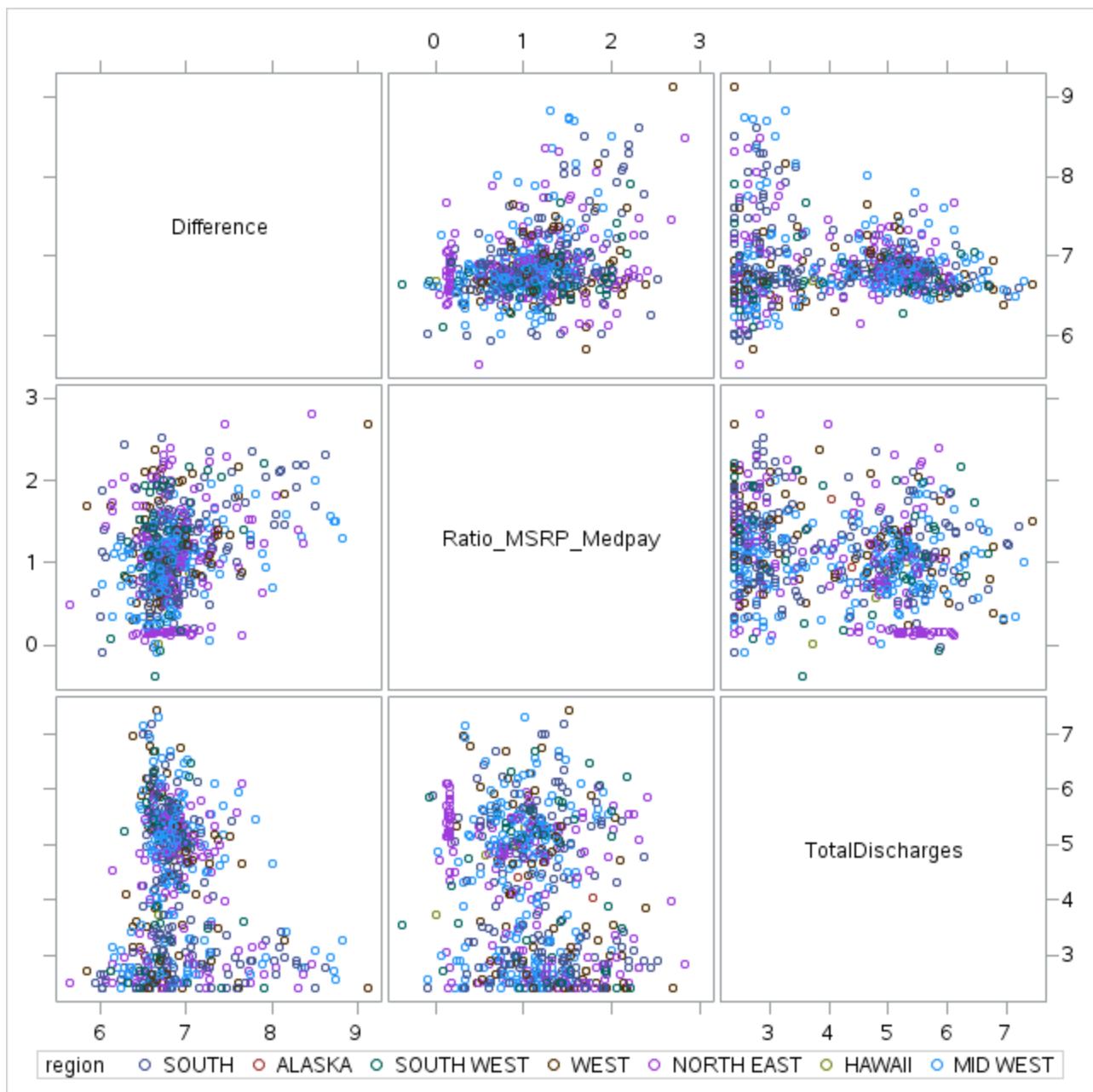
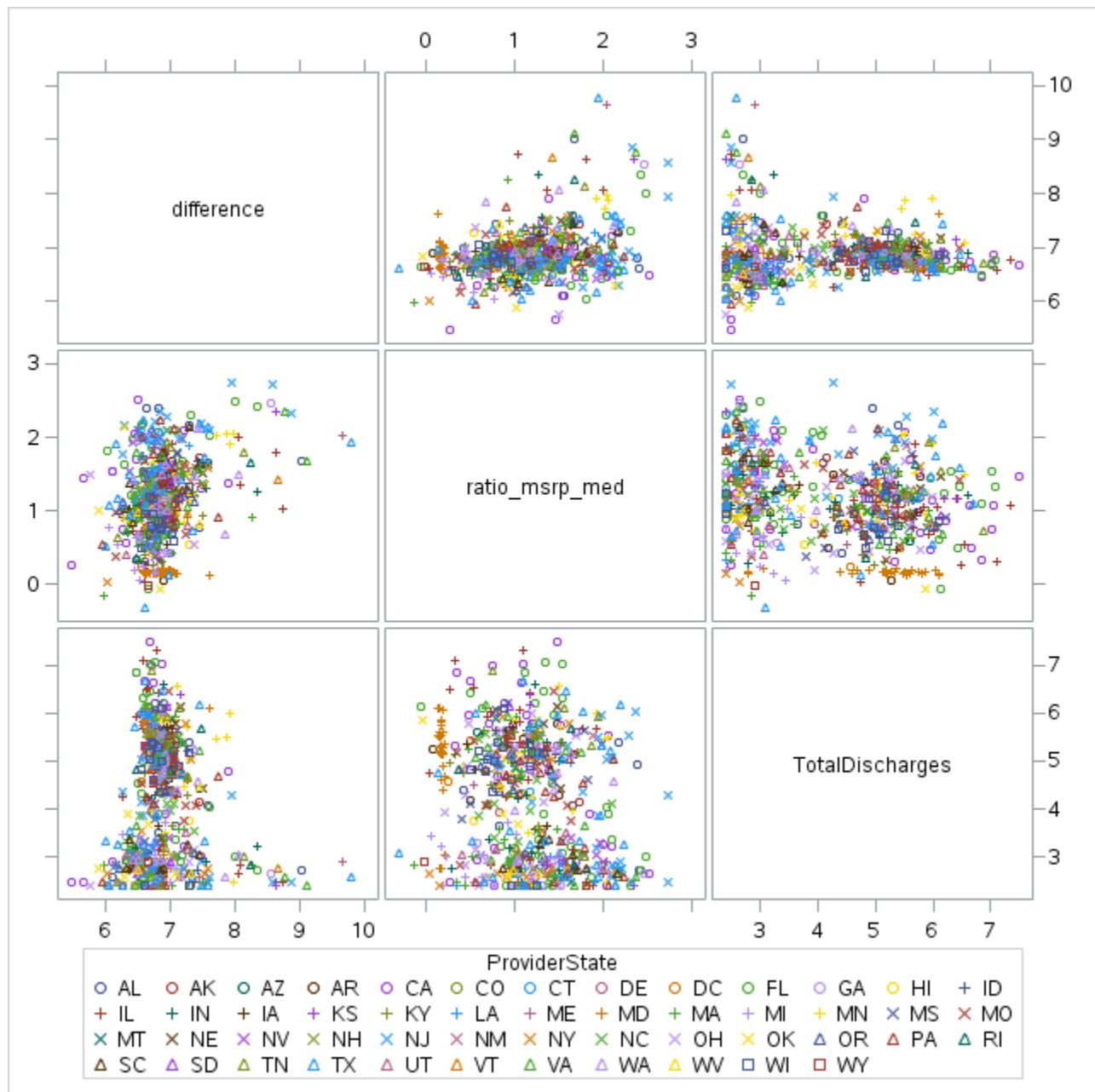


Figure 8: Scatterplot matrix by state and region, for year 2012.



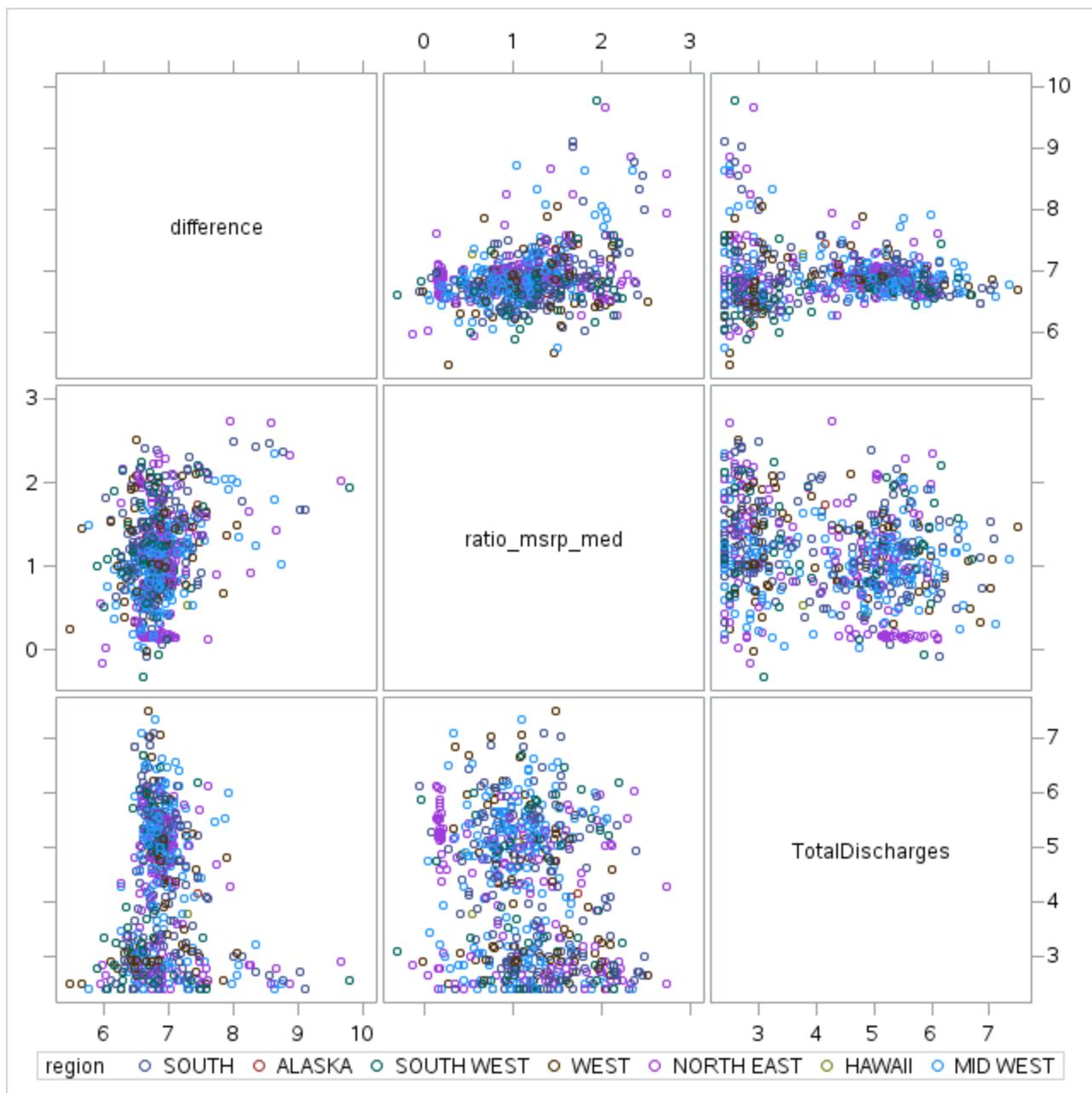
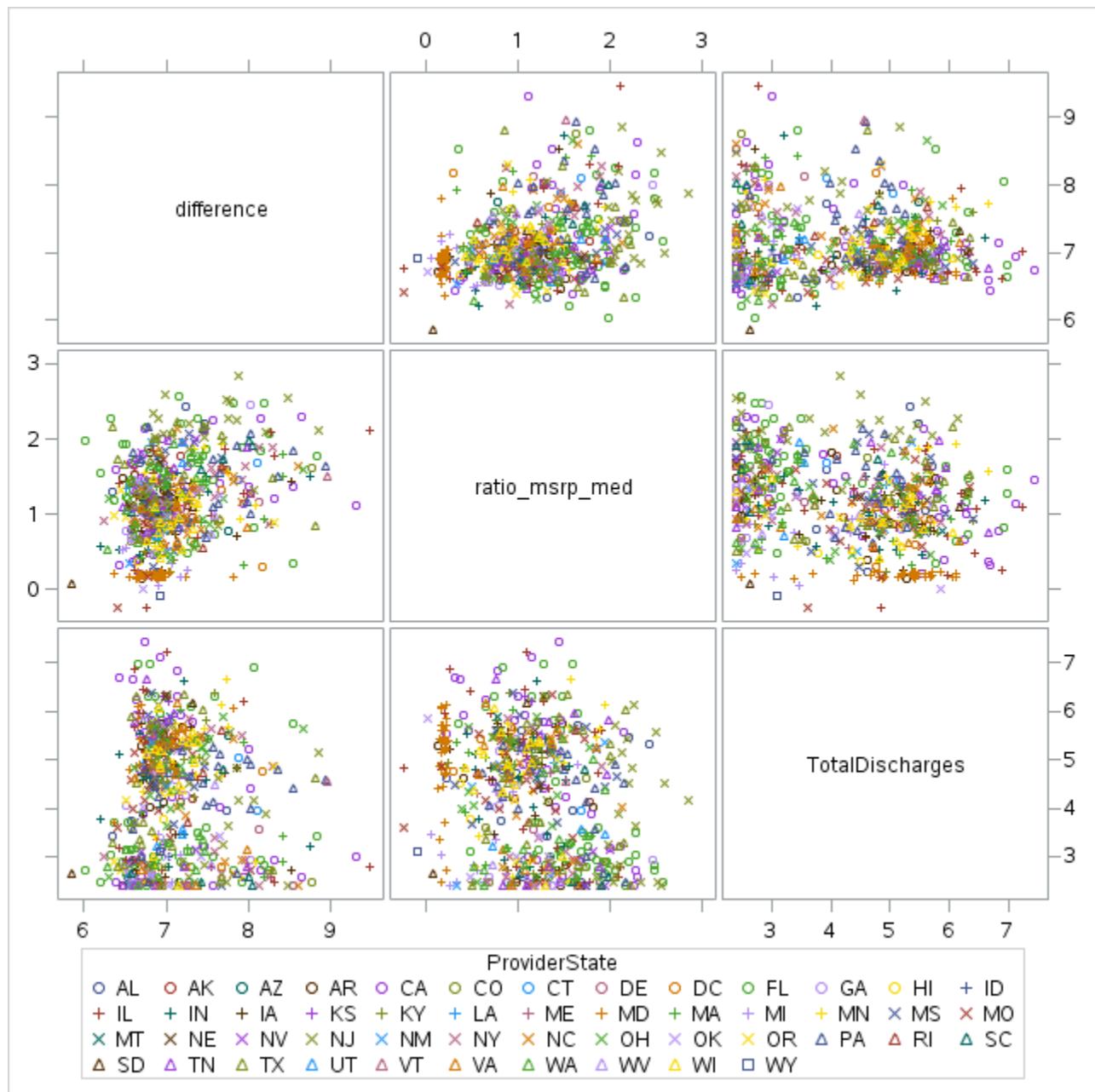


Figure 9: Scatterplot matrix by state and region, for year 2013.



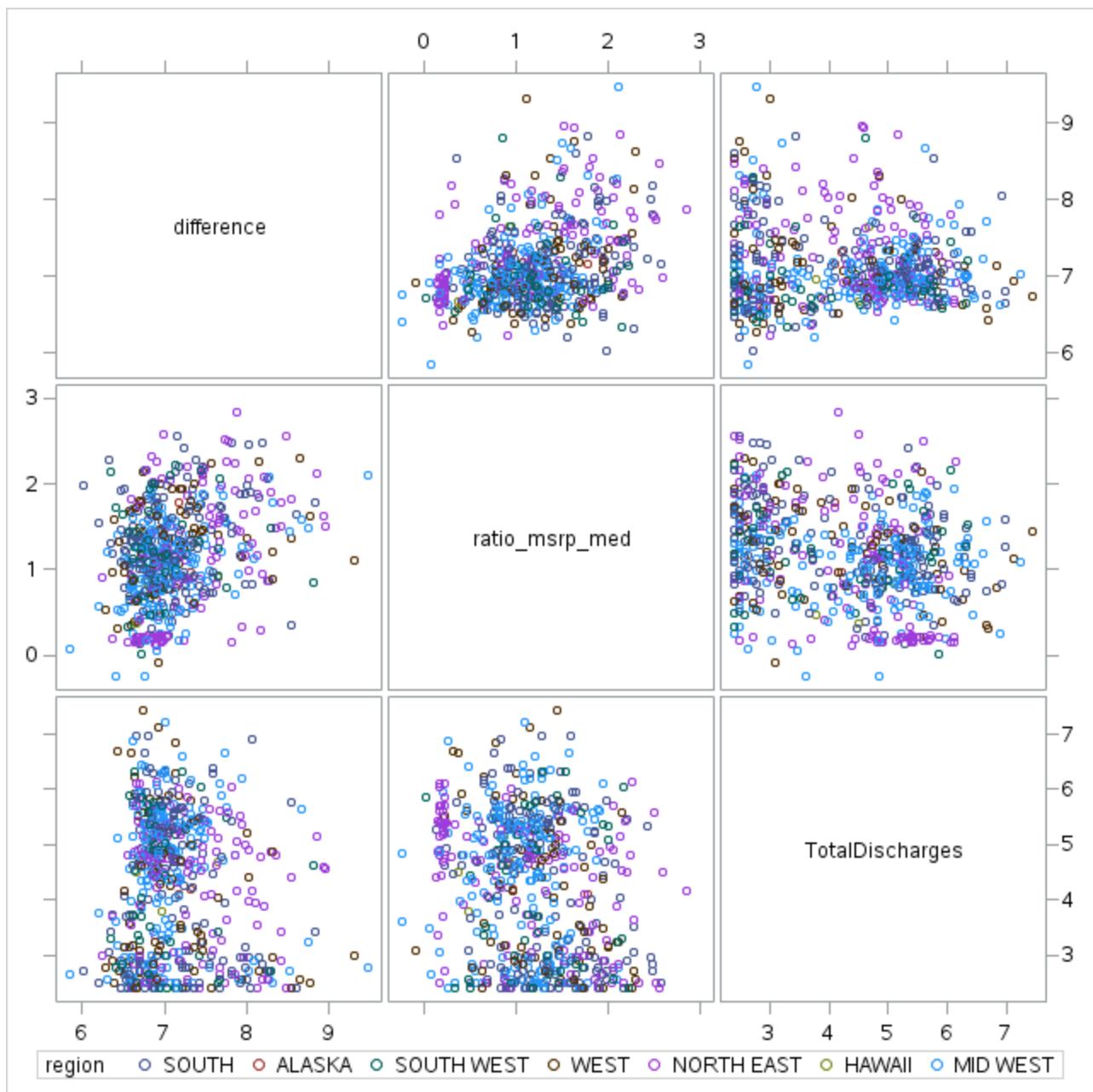


Figure 10: Bubble plot for 3 clusters, for year 2011.

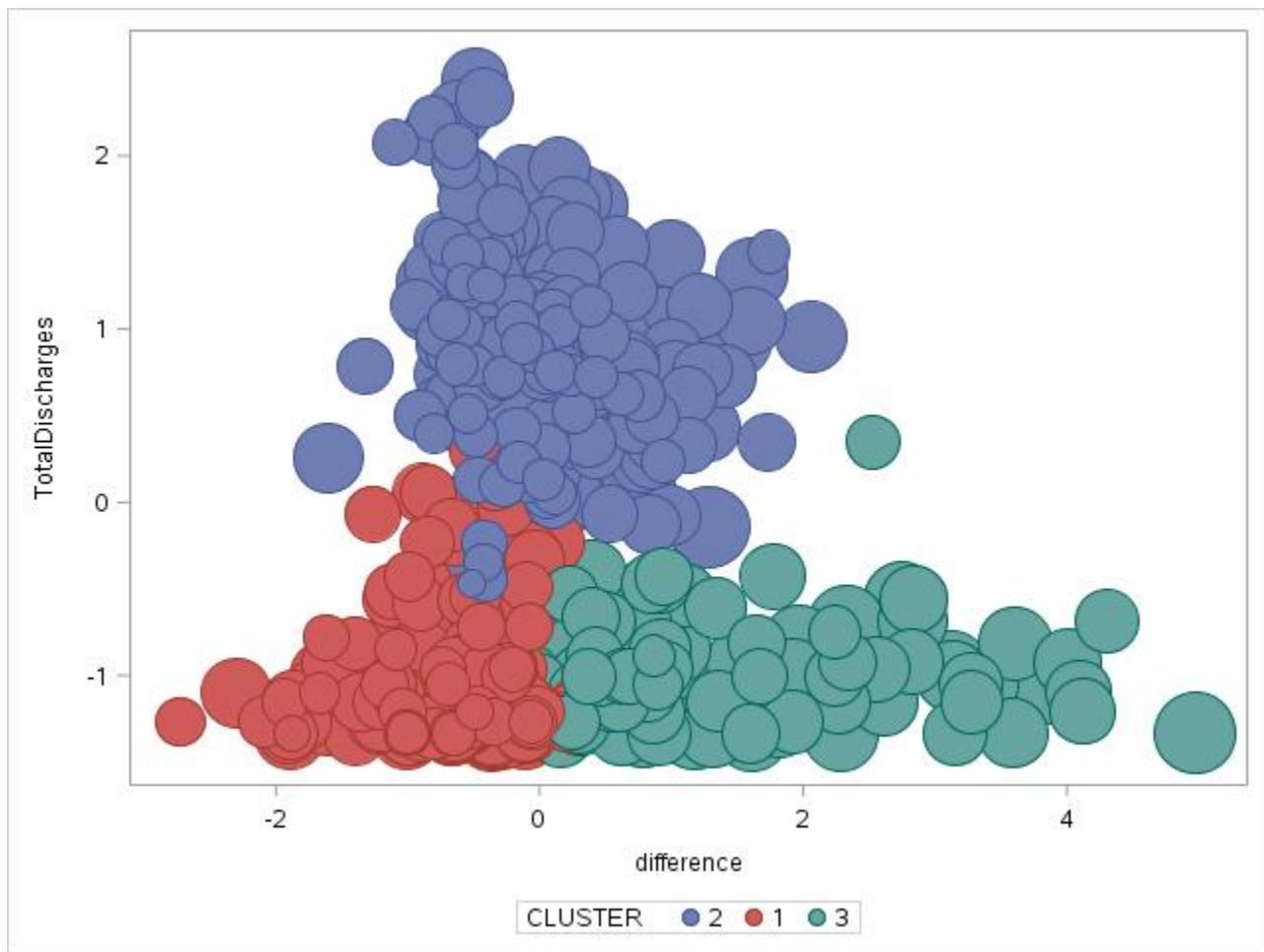


Figure 11: Bubble plot for 3 clusters, for year 2012.

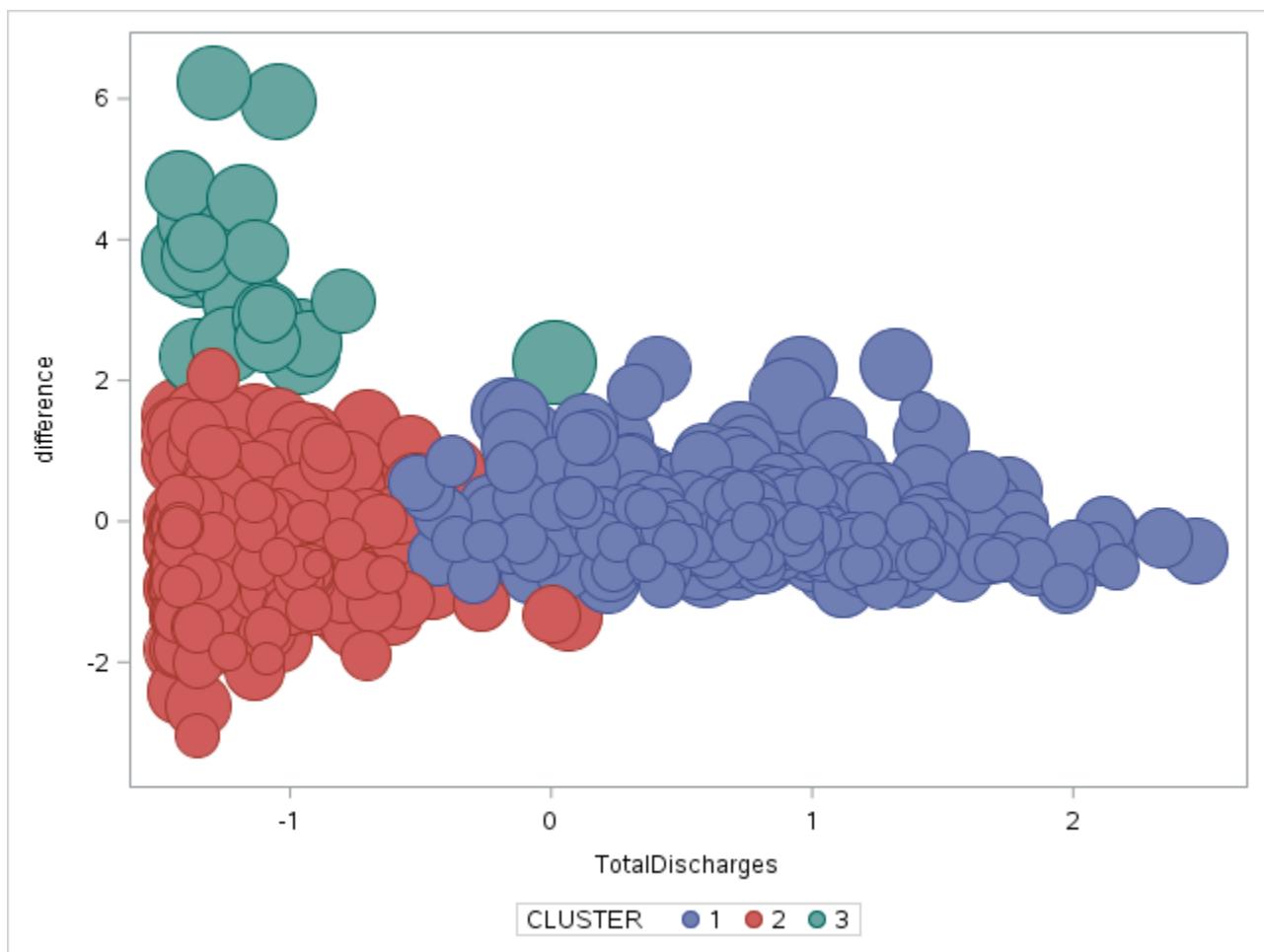
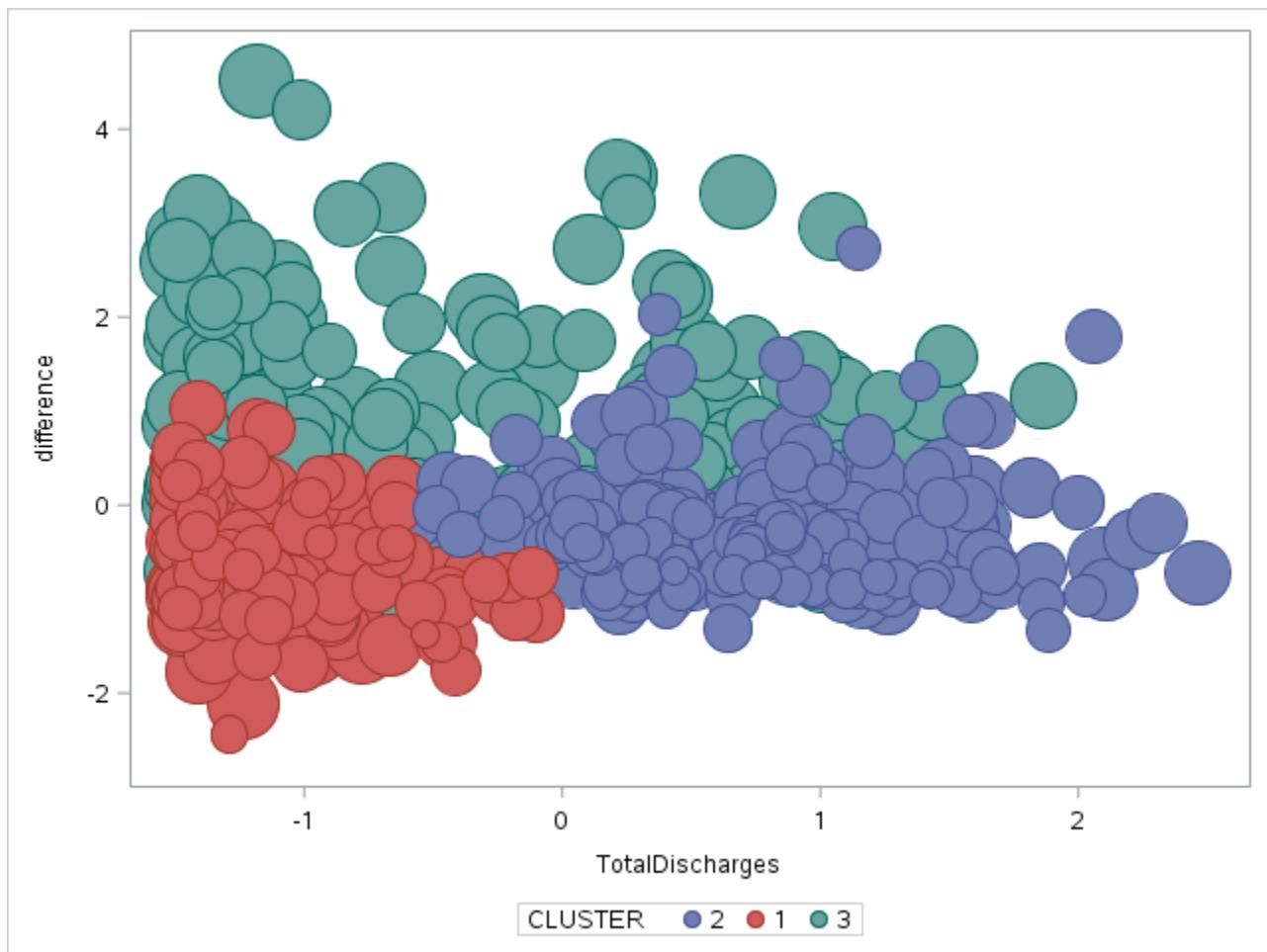


Figure 12: Bubble plot for 3 clusters, for year 2013.



Appendix B

Table 1: Variable description.

| | |
|---------------------------|---|
| DRG Definition | The code and description identifying the MS-DRG. MS-DRGs are a classification system that groups similar clinical conditions (diagnoses) and the procedures furnished by the hospital during the stay. |
| Provider Id | The CMS Certification Number (CCN) assigned to the Medicare certified hospital facility. |
| Provider Name | The name of the provider. |
| Provider Street Address | The provider's street address. |
| Provider City | The city where the provider is located. |
| Provider State | The state where the provider is located. |
| Provider Zip Code | The provider's zip code. |
| Provider HRR | The Hospital Referral Region (HRR) where the provider is located. |
| Total Discharges | The number of discharges billed by the provider for inpatient hospital services. |
| Average Covered Charges | The provider's average charge for services covered by Medicare for all discharges in the DRG. These will vary from hospital to hospital because of differences in hospital charge structures. |
| Average Total Payments | The average total payments to all providers for the MS-DRG including the MS-DRG amount, teaching, disproportionate share, capital, and outlier payments for all cases. Also included in average total payments are co-payment and deductible amounts that the patient is responsible for and any additional payments by third parties for coordination of benefits. |
| Average Medicare Payments | The average amount that Medicare pays to the provider for Medicare's share of the MS-DRG. Average Medicare payment amounts include the MS-DRG amount, teaching, disproportionate share, capital, and outlier payments for all cases. Medicare payments DO NOT include beneficiary co-payments and deductible amounts nor any additional payments from third parties for coordination of benefits. |

*Taken from the methodological overview file for Medicare fee-for service provider utilization and payment data inpatient public use file⁶.

Table 2: DRG group, discharges and expenditures.

| DRG group | Discharges | | | Expenditures | | |
|------------------------------------|----------------|----------|----------|---------------|----------|----------|
| | (In Thousands) | | % Change | (in Billions) | | % Change |
| | 2011 | 2013 | | 2011 | 2013 | |
| 190 COPD | 412,787 | 370,800 | -10.17 | 2.34 | 2.10 | -10.10 |
| 193 SIMPLE PNEUMONIA & PLEURISY | 406,092 | 389,523 | -4.08 | 2.60 | 2.55 | -2.15 |
| 291 HEART FAILURE & SHOCK | 496,768 | 455,106 | -8.39 | 3.50 | 3.27 | -6.65 |
| MAJOR JOINT REPLACEMENT OR | | | | | | |
| 469 REATTACH | | | | | | |
| OF LOWER EXTREMITY | 445,797 | 463,424 | 3.95 | 5.53 | 5.76 | 4.02 |
| 870 870 - SEPTICEMIA/SEVERE SEPSIS | 454,082 | 548,049 | 20.69 | 5.76 | 6.89 | 19.80 |
| | Per 10K | % Change | | Per Discharge | % Change | |
| 190 COPD | 13.25 | 11.73 | -11.46 | 5669.39 | 5673.61 | 0.07 |
| 193 SIMPLE PNEUMONIA & PLEURISY | 13.03 | 12.32 | -5.46 | 6414.58 | 6543.37 | 2.01 |
| 291 HEART FAILURE & SHOCK | 15.94 | 14.40 | -9.70 | 7048.24 | 7181.50 | 1.89 |
| MAJOR JOINT REPLACEMENT OR | | | | | | |
| 469 REATTACH | | | | | | |
| OF LOWER EXTREMITY | 14.31 | 14.66 | 2.46 | 12414.36 | 12422.26 | 0.06 |
| 870 870 - SEPTICEMIA/SEVERE SEPSIS | 14.57 | 17.34 | 18.96 | 12674.80 | 12580.48 | -0.74 |

Table 3: Membership of mental illness providers regions by clusters and year.

| | 2011 | | | 2012 | | | 2013 | | |
|--------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| | Cluster 1 | Cluster 2 | Cluster 3 | Cluster 1 | Cluster 2 | Cluster 3 | Cluster 1 | Cluster 2 | Cluster 3 |
| South | 58 | 101 | 37 | 110 | 72 | 7 | 50 | 91 | 58 |
| Mid | 55 | 85 | 22 | 99 | 55 | 7 | 47 | 74 | 54 |
| West | | | | | | | | | |
| North | 36 | 76 | 21 | 80 | 46 | 7 | 20 | 55 | 33 |
| East | | | | | | | | | |
| West | 26 | 38 | 11 | 38 | 37 | 1 | 17 | 25 | 33 |
| South | 10 | 26 | 5 | 25 | 26 | 1 | 13 | 16 | 12 |
| West | | | | | | | | | |
| Hawaii | 0 | 4 | 0 | 4 | 0 | 0 | 0 | 4 | 0 |
| Alaska | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 1 | 1 |

Appendix C

Figure 13: Rates of hospitalization per 10K for septicemia in 2011 and with compound rates of change 2011-2013).

