Web appendix: Supplementary materials

Appendix 1: Comparison of OptumLabs Data Warehouse population to US insured population

Table A1: Under 65 privately insured population, 2015

	US privately insured	OLDW commercial
Race/ethnicity		
White	66%	70%
Asian	7%	6%
Hispanic	15%	14%
Black	11%	11%
American Indian	1%	N/A
Female	50%	49%
Age		
0 to 17	24%	22%
18 to 24	11%	11%
25 to 34	16%	18%
35 to 44	15%	17%
45 to 54	17%	18%
55 to 59	9%	8%
60 to 64	7%	6%
Census Division		
New England	5%	3%
Mid Atlantic	13%	7%
East North Central	15%	16%
West North Central	6%	11%
South Atlantic	20%	22%
East South Central	6%	4%
West South Central	12%	18%
Mountain	7%	10%
Pacific	16%	9%

OLDW commercial includes people with both medical and prescription coverage; excludes people with unknown race/ethnicity, year of birth, or sex
Source: CPS ASEC (Current Population Survey—Annual Social and Economic Supplement), data for 2015, using https://www.census.gov/cps/data/cpstablecreator.html; Includes only people listed with a single race. Hispanic includes people of any single race who indicated they were of Hispanic origin

Table A2: Medicare Advantage, 2015

	US Medicare Advantage	OLDW Medicare Advantage
Race/ethnicity		
White	76%	76%
Black	11%	12%
Hispanic	8%	9%
Other	6%	3%
Female	55%	57%
Census Division		
New England	3%	6%
Mid Atlantic	15%	15%
East North Central	15%	18%
West North Central	6%	12%
South Atlantic	20%	31%
East South Central	6%	5%
West South Central	10%	4%
Mountain	7%	5%
Pacific	18%	3%

OLDW Medicare Advantage includes people with both medical and prescription coverage; excludes people with unknown race/ethnicity or sex
US Medicare Advantage source: Kaiser Family Foundation, 2015 data
https://www.kff.org/state-category/medicare/medicare-advantage/

Appendix 2: Data access, cleaning, and sharing

Access to the OptumLabs Data Warehouse is carefully controlled to protect the privacy of beneficiaries. As a result, only Dr. Jeffery had access to beneficiary-level data . All authors had unlimited access to summarized data, such as that used to create the figures and tables.

Data cleaning: selection of opioid fills is described in Appendix 2. Selection of beneficiaries was based on enrollment data showing that they were either commercial enrollees with both medical and prescription drug coverage ***or*** Medicare Advantage enrollees with both medical and prescription drug coverage for whom fee-for-service Medicare was not recorded as the primary payer.

Data sharing: OptumLabs data are deidentified and available for research through a virtual data warehouse. OptumLabs has agreed to make the dataset for this study and the accompanying code available to interested researchers interested in replicating the findings through a virtual data warehouse. Interested researchers can contact the corresponding author for the manuscript and the author will facilitate access to the data and code for the researchers.

Appendix 3: Opioid drugs included/excluded; MME conversion factors

We identified all opioid drugs present in the table of NDC codes in OptumLabs Data Warehouse. For the purposes of this analysis, we classified tramadol as an opioid. We excluded DEA schedule 5 drugs (e.g., codeine cough syrups).
To limit the sample to drugs intended for home use, we excluded any injected or infused drug—those for which the dosage form was vial, syringe, ampule, cartridge, IV solution, etc.
We included only drugs which had a defined dose unit like a tablet, pill, mg/mL, etc. This excludes drugs in powder or bulk form.
We included both single drug formulations and combinations of drugs. Table A1 includes all opioid drug combinations found in the table of NDC codes. Both long-acting and short-acting formulations were included.

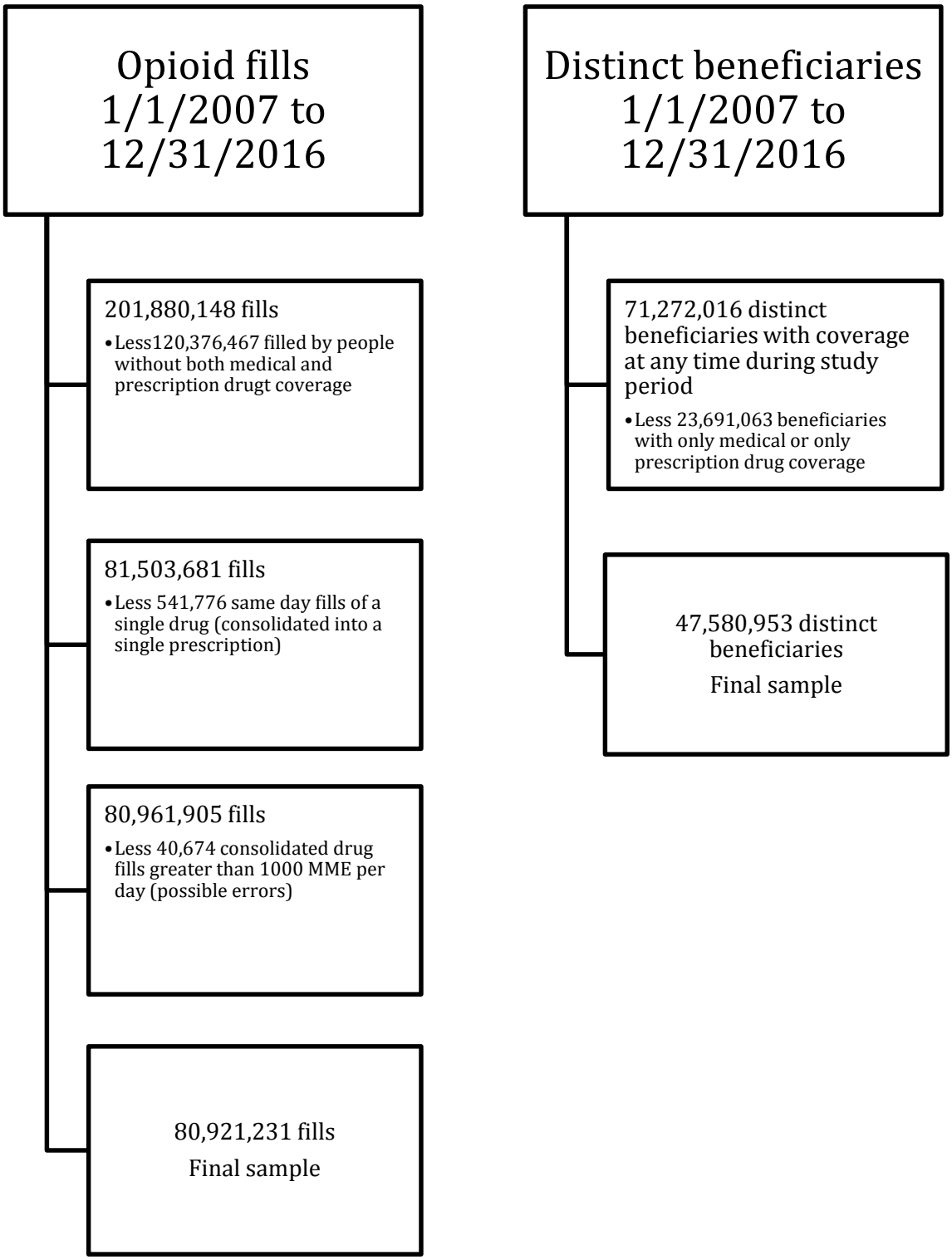
Conversion factors were taken from the CDC compilation[1] except for propoxyphene. The CDC uses a single conversion factor for all propoxyphene salts. However, according to the drug monograph, propoxyphene napsylate and propoxyphene hydrochloride have different doses for the same effect due to differences in the weight of the molecule. According to the monograph, a 65mg dose of the hydrochloride is equivalent to a 100mg dose of the napsylate.[2] The 0.23 conversion factor given for propoxyphene in the CDC compilation applies to the HCl salt: 130 mg propoxyphene HCl=30 mg morphine. With 65mg propoxyphene HCl=100mg propoxyphene napsylate, this implies a conversion factor to morphine of 0.15 for the napsylate, which is what we have used in the paper. Since the napsylate was far more common than the hydrochloride, this ends up being conservative relative to the CDC conversion factors—in other words, it reduces the total estimated MME of propoxyphene dispensed.

Table A3 Opioid drugs and combinations included

Opioid	Drug combinations included	Long acting	Short acting	Conversion factor*
Buprenorphine	Buprenorphine	X		10 Patch version: 12.6
	Buprenorphine/Naloxone	X		10
Butorphanol	Butorphanol		X	7
Codeine	Codeine		X	0.15
	Codeine/Acetaminophen		X	0.15
	Codeine/Acetaminophen/ Butabarbital		X	0.15

Opioid	Drug combinations included	Long acting	Short acting	Conversion factor*
	Codeine/Acetaminophen/ Butalbital		X	0.15
	Codeine/Aspirin		X	0.15
	Codeine/Aspirin/Butalbital/ Caffeine		X	0.15
	Codeine/Aspirin/Carisoprodol		X	0.15
	Codeine/Aspirin/Phenacetin/ Caffeine		X	0.15
Dihydrocodeine	Dihydrocodeine/Acetaminophen/ Caffeine		X	0.25
	Dihydrocodeine/Aspirin/Caffeine		X	0.25
Fentanyl	Fentanyl	X	X	LA: 0.72 SA: 0.13 - 0.18
Hydrocodone	Hydrocodone	X	X	1
	Hydrocodone/Acetaminophen		X	1
	Hydrocodone/Acetaminophen/Diet.Sup.11		X	1
	Hydrocodone/Aspirin		X	1
	Hydrocodone/Ibuprofen		X	1
Hydromorphone	Hydromorphone	X	X	4
Levomethadyl	Levomethadyl	X		8
Levorphanol	Levorphanol	X		11
Meperidine	Meperidine/Acetaminophen		X	0.1
	Meperidine/Promethazine		X	0.1
Methadone	Methadone	X		3
Morphine	Morphine Sulfate	X	X	1
	Morphine Sulfate/Naltrexone	X		1
Opium	Opium		X	1
	Opium/Belladonna		X	1
Oxycodone	Oxycodone	X	X	1.5
	Oxycodone/Acetaminophen		X	1.5
	Oxycodone/Aspirin		X	1.5
	Oxycodone/Ibuprofen		X	1.5
Oxymorphone	Oxymorphone	X	X	3
Pentazocine	Pentazocine/Acetaminophen		X	0.37
	Pentazocine/Aspirin		X	0.37
	Pentazocine/Naloxone		X	0.37
Propoxyphene[2]	Propoxyphene		X	0.23 for HCl salt 0.15 for Napsylate
	Propoxyphene/Acetaminophen		X	0.23 for HCl salt 0.15 for Napsylate
	Propoxyphene/Aspirin/Caffeine		X	0.23 for HCl salt 0.15 for Napsylate
Tapentadol	Tapentadol	X	X	0.4
Tramadol	Tramadol	X	X	0.1
	Tramadol/Acetaminophen		X	0.1
	Tramadol/Dietary Supplement No. 11		X	0.1
* Factor used to convert mg of drug to mg of morphine equivalents[1]				

Appendix 4: Cohort flow charts



Appendix 5: Note on standard error calculations for marginal effects

Due to limits in computing resources, we did not calculate standard errors for marginal effect estimates of adjusted time trends in quarterly prevalence of opioid use or for age trends. In general with very large sample sizes, statistical significance becomes much less important than clinical significance; we expect that most differences in quarterly use prevalence are statistically significant at the 95% level, but many differences are so small as to be of limited clinical significance. We present the regression results with standard errors for reference.

Appendix 6: Elixhauser comorbidity prevalence

Table A4: Elixhauser comorbidities by beneficiary category

Elixhauser comorbidities	Commercial	Aged Medicare	Disabled Medicare
Alcohol abuse	1%	1%	2%
Blood loss anemia	0%	1%	0%
Cardiac Arrhythmia	6%	17%	8%
Chronic Pulmonary disease	13%	15%	19%
Coagulopathy	1%	2%	2%
Congestive heart failure	2%	10%	7%
Deficiency anemia	2%	3%	3%
Depression	11%	7%	17%
Diabetes with chronic complications	3%	8%	10%
Diabetes without chronic complications	20%	28%	31%
Drug abuse	2%	0%	4%
Fluid and electrolyte disorders	4%	7%	8%
HIV/AIDS	1%	0%	1%
Hypothyroidism	9%	10%	8%
Liver disease	2%	1%	4%
Lymphoma	1%	1%	1%
Metastatic cancer	1%	1%	1%
Obesity	6%	2%	8%
Other neurological disorders	3%	5%	10%
Paralysis	0%	1%	2%
Peptic ulcer	0%	0%	0%
Peripheral vascular disease	1%	7%	5%
Psychosis	1%	2%	6%
Pulmonary Circulation Disorder	1%	2%	2%
Renal failure	2%	9%	6%
Rheumatoid arthritis	4%	4%	7%
Solid tumor without metastasis	6%	8%	4%
Uncomplicated hypertension	42%	65%	52%
Valvular disease	2%	5%	3%
Weight Loss	1%	2%	2%

Calculated quarterly on a rolling basis, looking back 6 months. Required 1 inpatient or 2 outpatient dates of service with diagnosis from list of ICD9 (2007 through 9/2015) and ICD10 (10/2015 through 2016) codes published in Quan et al.[3]

Appendix 7: Regression results

Negative binomial regression

Number of obs	19,622,773
Wald chi2(150)	168972.44
Prob > chi2	0.000
Pseudo R2	0.0106

Dispersion = mean

Log pseudolikelihood = -1.638e+08

(Std. Err. adjusted for 5,754,195 clusters in optum_lab_id)

Dependent variable: Total MME in the quarter

	IRR	Std. Err.	z	P>z	[95% Conf.	Interval]
yr						
2007	(ref)					
2008	1.050	0.008	6.55	0.000	1.035	1.066
2009	1.122	0.010	13.17	0.000	1.103	1.141
2010	1.200	0.012	18.96	0.000	1.177	1.223
2011	1.167	0.012	15.32	0.000	1.144	1.191
2012	1.149	0.012	13.39	0.000	1.126	1.172
2013	1.168	0.012	14.75	0.000	1.144	1.193
2014	1.180	0.013	15.23	0.000	1.155	1.206
2015	1.168	0.013	13.89	0.000	1.143	1.194
2016	1.156	0.013	13.03	0.000	1.131	1.181
qrtr						
1	(ref)					
2	1.033	0.005	7.26	0.000	1.024	1.042
3	1.048	0.006	8.23	0.000	1.037	1.060
4	1.085	0.007	12.55	0.000	1.071	1.099
yr#qrtr						
2008#2	0.999	0.006	-0.16	0.873	0.987	1.011
2008#3	1.001	0.008	0.17	0.866	0.985	1.018
2008#4	1.007	0.010	0.75	0.455	0.988	1.026
2009#2	0.985	0.006	-2.41	0.016	0.974	0.997
2009#3	0.996	0.008	-0.46	0.648	0.981	1.012
2009#4	0.996	0.009	-0.39	0.697	0.979	1.014
2010#2	0.986	0.006	-2.26	0.024	0.975	0.998
2010#3	0.970	0.008	-3.78	0.000	0.956	0.986
2010#4	0.939	0.008	-6.97	0.000	0.922	0.956
2011#2	0.984	0.006	-2.69	0.007	0.972	0.996

	IRR	Std. Err.	z	P>z	[95% Conf.	Interval]
2011#3	0.967	0.008	-4.29	0.000	0.953	0.982
2011#4	0.939	0.008	-7.15	0.000	0.922	0.955
2012#2	0.985	0.006	-2.58	0.010	0.973	0.996
2012#3	0.973	0.007	-3.54	0.000	0.959	0.988
2012#4	0.949	0.008	-6.12	0.000	0.933	0.965
2013#2	0.972	0.006	-4.7	0.000	0.961	0.984
2013#3	0.965	0.007	-4.72	0.000	0.951	0.979
2013#4	0.939	0.008	-7.31	0.000	0.923	0.955
2014#2	0.983	0.006	-2.79	0.005	0.971	0.995
2014#3	0.961	0.008	-5.03	0.000	0.947	0.976
2014#4	0.923	0.008	-8.9	0.000	0.907	0.940
2015#2	0.986	0.006	-2.29	0.022	0.974	0.998
2015#3	0.959	0.007	-5.42	0.000	0.944	0.973
2015#4	0.935	0.008	-7.64	0.000	0.919	0.951
2016#2	0.998	0.006	-0.41	0.680	0.986	1.009
2016#3	0.971	0.007	-3.93	0.000	0.957	0.985
2016#4	0.933	0.008	-8.15	0.000	0.917	0.949
bene_cat						
com	(ref)					
aged_mcr	1.541	0.030	22.05	0.000	1.483	1.602
disab_mcr	3.165	0.054	67.42	0.000	3.061	3.273
yr#bene_cat						
2008#aged_mcr	0.994	0.011	-0.49	0.622	0.972	1.017
2008#disab_mcr	1.028	0.016	1.81	0.070	0.998	1.059
2009#aged_mcr	0.938	0.012	-5.01	0.000	0.915	0.962
2009#disab_mcr	1.020	0.017	1.15	0.250	0.986	1.055
2010#aged_mcr	0.807	0.011	-16.09	0.000	0.787	0.829
2010#disab_mcr	0.969	0.017	-1.75	0.081	0.936	1.004
2011#aged_mcr	0.791	0.011	-17.1	0.000	0.770	0.813
2011#disab_mcr	1.047	0.019	2.51	0.012	1.010	1.085
2012#aged_mcr	0.834	0.011	-13.19	0.000	0.812	0.857
2012#disab_mcr	1.099	0.020	5.19	0.000	1.061	1.139
2013#aged_mcr	0.827	0.011	-13.87	0.000	0.805	0.849
2013#disab_mcr	1.067	0.020	3.53	0.000	1.029	1.106
2014#aged_mcr	0.843	0.012	-12.31	0.000	0.820	0.866
2014#disab_mcr	1.014	0.019	0.75	0.451	0.978	1.052
2015#aged_mcr	0.859	0.012	-10.9	0.000	0.836	0.883

	IRR	Std. Err.	z	P>z	[95% Conf.	Interval]
2015#disab_mcr	1.032	0.019	1.71	0.087	0.995	1.071
2016#aged_mcr	0.881	0.012	-9.37	0.000	0.858	0.905
2016#disab_mcr	0.936	0.017	-3.62	0.000	0.903	0.970
qrtr#bene_cat						
2#aged_mcr	0.981	0.008	-2.42	0.016	0.967	0.996
2#disab_mcr	0.995	0.010	-0.52	0.604	0.975	1.015
3#aged_mcr	0.975	0.009	-2.66	0.008	0.957	0.993
3#disab_mcr	0.967	0.012	-2.77	0.006	0.944	0.990
4#aged_mcr	0.950	0.010	-4.98	0.000	0.931	0.969
4#disab_mcr	0.955	0.013	-3.45	0.001	0.930	0.980
yr#qrtr#bene_cat						
2008#2#aged_mcr	1.002	0.011	0.23	0.819	0.982	1.023
2008#2#disab_mcr	1.019	0.014	1.34	0.179	0.992	1.046
2008#3#aged_mcr	1.013	0.013	1	0.319	0.987	1.040
2008#3#disab_mcr	1.045	0.018	2.6	0.009	1.011	1.081
2008#4#aged_mcr	1.026	0.015	1.7	0.090	0.996	1.056
2008#4#disab_mcr	1.046	0.020	2.34	0.019	1.007	1.087
2009#2#aged_mcr	0.971	0.010	-2.94	0.003	0.952	0.990
2009#2#disab_mcr	0.997	0.012	-0.2	0.838	0.973	1.022
2009#3#aged_mcr	0.944	0.012	-4.71	0.000	0.921	0.967
2009#3#disab_mcr	1.003	0.015	0.19	0.851	0.973	1.033
2009#4#aged_mcr	0.904	0.012	-7.33	0.000	0.880	0.929
2009#4#disab_mcr	0.981	0.017	-1.12	0.264	0.949	1.014
2010#2#aged_mcr	1.013	0.010	1.36	0.172	0.994	1.032
2010#2#disab_mcr	1.013	0.012	1.13	0.260	0.990	1.037
2010#3#aged_mcr	1.027	0.012	2.31	0.021	1.004	1.051
2010#3#disab_mcr	1.037	0.015	2.51	0.012	1.008	1.067
2010#4#aged_mcr	1.029	0.013	2.21	0.027	1.003	1.055
2010#4#disab_mcr	1.062	0.017	3.76	0.000	1.029	1.096
2011#2#aged_mcr	1.009	0.009	0.97	0.334	0.991	1.027
2011#2#disab_mcr	1.022	0.012	1.93	0.054	1.000	1.045
2011#3#aged_mcr	1.020	0.012	1.76	0.079	0.998	1.043
2011#3#disab_mcr	1.043	0.015	3	0.003	1.015	1.072
2011#4#aged_mcr	1.045	0.013	3.5	0.000	1.020	1.071
2011#4#disab_mcr	1.047	0.016	2.97	0.003	1.016	1.080
2012#2#aged_mcr	1.009	0.009	0.93	0.351	0.991	1.027
2012#2#disab_mcr	1.000	0.011	-0.01	0.992	0.978	1.022

	IRR	Std. Err.	z	P>z	[95% Conf.	Interval]
2012#3#aged_mcr	1.006	0.011	0.54	0.587	0.984	1.028
2012#3#disab_mcr	1.011	0.014	0.76	0.450	0.983	1.038
2012#4#aged_mcr	1.026	0.013	2.1	0.036	1.002	1.051
2012#4#disab_mcr	1.018	0.016	1.14	0.253	0.988	1.048
2013#2#aged_mcr	0.998	0.009	-0.22	0.829	0.981	1.016
2013#2#disab_mcr	0.982	0.011	-1.6	0.110	0.961	1.004
2013#3#aged_mcr	0.994	0.011	-0.53	0.597	0.973	1.016
2013#3#disab_mcr	0.981	0.013	-1.38	0.167	0.955	1.008
2013#4#aged_mcr	1.016	0.012	1.31	0.191	0.992	1.041
2013#4#disab_mcr	0.983	0.015	-1.16	0.247	0.954	1.012
2014#2#aged_mcr	0.995	0.009	-0.6	0.550	0.977	1.013
2014#2#disab_mcr	1.000	0.011	0.02	0.982	0.978	1.023
2014#3#aged_mcr	1.005	0.011	0.47	0.637	0.983	1.028
2014#3#disab_mcr	1.027	0.014	1.96	0.051	1.000	1.056
2014#4#aged_mcr	1.049	0.013	3.82	0.000	1.023	1.075
2014#4#disab_mcr	1.057	0.016	3.59	0.000	1.025	1.089
2015#2#aged_mcr	0.994	0.009	-0.7	0.481	0.976	1.012
2015#2#disab_mcr	0.982	0.011	-1.6	0.110	0.961	1.004
2015#3#aged_mcr	1.009	0.011	0.82	0.410	0.987	1.032
2015#3#disab_mcr	1.008	0.014	0.59	0.553	0.981	1.036
2015#4#aged_mcr	1.037	0.013	2.98	0.003	1.013	1.063
2015#4#disab_mcr	1.021	0.016	1.36	0.175	0.991	1.052
2016#2#aged_mcr	1.014	0.009	1.57	0.117	0.997	1.032
2016#2#disab_mcr	0.999	0.011	-0.11	0.910	0.977	1.021
2016#3#aged_mcr	1.022	0.011	2	0.045	1.000	1.044
2016#3#disab_mcr	1.020	0.014	1.47	0.140	0.993	1.047
2016#4#aged_mcr	1.052	0.013	4.24	0.000	1.028	1.077
2016#4#disab_mcr	1.037	0.015	2.47	0.014	1.008	1.068
Coverage cohort (first year of insurance coverage)						
pre-2007	(ref)					
2007	0.995	0.011	-0.51	0.609	0.974	1.016
2008	1.000	0.010	-0.02	0.980	0.981	1.019
2009	0.971	0.009	-3.2	0.001	0.953	0.989
2010	0.968	0.009	-3.56	0.000	0.951	0.985
2011	0.988	0.009	-1.27	0.205	0.971	1.006
2012	0.979	0.009	-2.28	0.023	0.961	0.997
2013	0.957	0.009	-4.69	0.000	0.940	0.975
2014	0.896	0.008	-11.73	0.000	0.880	0.913

	IRR	Std. Err.	z	P>z	[95% Conf.	Interval]
2015	0.903	0.009	-10.75	0.000	0.886	0.920
2016	0.916	0.009	-8.93	0.000	0.899	0.934
1.female	0.866	0.004	-32.98	0.000	0.859	0.874
Age						
0-18	0.188	0.002	-159.5	0.000	0.184	0.192
19-34	0.625	0.006	-49.68	0.000	0.613	0.636
35-44	(ref)					
45-54	1.199	0.010	22.19	0.000	1.180	1.218
55-64	1.022	0.009	2.5	0.013	1.005	1.039
65-74	0.939	0.016	-3.68	0.000	0.908	0.971
75+	0.701	0.013	-19.84	0.000	0.677	0.726
unk	1.574	0.902	0.79	0.429	0.512	4.837
Race/ethnicity						
White	(ref)					
Black	0.786	0.005	-38.98	0.000	0.776	0.795
Hispanic	0.716	0.007	-36.65	0.000	0.703	0.728
Asian	0.598	0.014	-22.79	0.000	0.572	0.625
Unknown/other	0.922	0.008	-9.14	0.000	0.906	0.938
Census Division						
New England	(ref)					
Mid Atlantic	0.965	0.013	-2.61	0.009	0.939	0.991
East North Central	0.817	0.010	-16.94	0.000	0.798	0.836
West North Central	0.740	0.010	-23.13	0.000	0.722	0.759
South Atlantic	0.937	0.011	-5.69	0.000	0.916	0.958
East South Central	0.915	0.012	-6.9	0.000	0.892	0.938
West South Central	0.774	0.010	-19.65	0.000	0.755	0.794
Mountain	1.086	0.015	6.13	0.000	1.057	1.114
Pacific	0.993	0.014	-0.5	0.619	0.965	1.022
Unk/Other	0.822	0.040	-4.02	0.000	0.747	0.904
_cons	20.984	0.304	209.82	0.000	20.396	21.589
ln(tot_person_days)	1.000	(exposure)				
/lnalpha	0.648	0.001			0.646	0.650

	IRR	Std. Err.	z	P>z	[95% Conf.	Interval]
alpha	1.912	0.002			1.908	1.916

Logistic regression		Number of obs	494,069,327
		Wald chi2(150)	4782017.54
		Prob > chi2	0
Log pseudolikelihood	= -1.27E+08	Pseudo R2	0.0823

(Std. Err. adjusted for 47,593,876 clusters in optum_lab_id)

Dependent variable: used opioids in quarter

	Odds Ratio	Std. Err.	z	P>z	[95% Conf.	Interval]
yr						
2007	1.060	0.002	37.81	0.000	1.057	1.064
2008	1.080	0.002	46.55	0.000	1.076	1.083
2009	1.088	0.002	48.23	0.000	1.084	1.092
2010	1.087	0.002	46.32	0.000	1.083	1.091
2011	1.096	0.002	49.19	0.000	1.092	1.100
2012	1.050	0.002	25.59	0.000	1.046	1.054
2013	1.008	0.002	4.18	0.000	1.004	1.012
2014	0.895	0.002	-52.89	0.000	0.891	0.898
2015	0.919	0.002	-40.05	0.000	0.915	0.922
2016						
qrtr						
1	(ref)					
2	1.023	0.001	16.52	0.000	1.020	1.026
3	1.028	0.002	18.97	0.000	1.025	1.031
4	1.039	0.002	25.20	0.000	1.036	1.042
yr#qrtr						
2008#2	0.986	0.002	-7.32	0.000	0.982	0.990
2008#3	0.991	0.002	-4.41	0.000	0.987	0.995
2008#4	0.993	0.002	-3.46	0.001	0.988	0.997
2009#2	1.003	0.002	1.52	0.129	0.999	1.007
2009#3	0.999	0.002	-0.44	0.661	0.995	1.003
2009#4	1.003	0.002	1.55	0.120	0.999	1.007
2010#2	1.000	0.002	0.09	0.929	0.996	1.004
2010#3	1.001	0.002	0.52	0.602	0.997	1.005
2010#4	1.002	0.002	0.76	0.447	0.997	1.006
2011#2	0.983	0.002	-8.87	0.000	0.979	0.987
2011#3	0.987	0.002	-6.02	0.000	0.983	0.992
	0.989	0.002	-5.12	0.000	0.985	0.993

	Odds Ratio	Std. Err.	z	P>z	[95% Conf.	Interval]
2011#4	0.981	0.002	-9.90	0.000	0.977	0.985
2012#2	0.969	0.002	-15.18	0.000	0.965	0.973
2012#3	0.977	0.002	-10.86	0.000	0.973	0.981
2012#4	0.979	0.002	-10.74	0.000	0.975	0.983
2013#2	0.972	0.002	-13.50	0.000	0.968	0.976
2013#3	0.976	0.002	-11.42	0.000	0.972	0.980
2013#4	0.996	0.002	-1.82	0.069	0.992	1.000
2014#2	0.950	0.002	-23.69	0.000	0.946	0.954
2014#3	0.919	0.002	-37.80	0.000	0.915	0.923
2014#4	1.021	0.002	10.29	0.000	1.017	1.025
2015#2	1.060	0.002	26.91	0.000	1.056	1.065
2015#3	1.064	0.002	27.78	0.000	1.059	1.068
2015#4	0.994	0.002	-2.89	0.004	0.990	0.998
2016#2	0.959	0.002	-19.51	0.000	0.955	0.963
2016#3	0.963	0.002	-17.24	0.000	0.959	0.967
2016#4						
bene_cat	(ref)					
com	1.040	0.005	7.61	0.000	1.030	1.051
aged_mcr	3.377	0.030	135.71	0.000	3.318	3.437
disab_mcr						
yr#bene_cat	1.049	0.005	9.58	0.000	1.039	1.060
2008#aged_mcr	1.124	0.010	12.73	0.000	1.104	1.144
2008#disab_mcr	1.038	0.005	7.38	0.000	1.028	1.049
2009#aged_mcr	1.314	0.013	28.53	0.000	1.289	1.339
2009#disab_mcr	1.157	0.006	28.97	0.000	1.146	1.169
2010#aged_mcr	1.491	0.014	41.40	0.000	1.463	1.519
2010#disab_mcr	1.252	0.006	44.52	0.000	1.240	1.265
2011#aged_mcr	1.726	0.017	55.95	0.000	1.694	1.760
2011#disab_mcr	1.238	0.006	42.36	0.000	1.225	1.250
2012#aged_mcr	1.783	0.017	59.53	0.000	1.749	1.817
2012#disab_mcr	1.328	0.007	56.56	0.000	1.315	1.341
2013#aged_mcr	1.872	0.018	64.74	0.000	1.836	1.908
2013#disab_mcr	1.311	0.007	53.64	0.000	1.299	1.325
2014#aged_mcr	1.889	0.018	65.17	0.000	1.853	1.925
2014#disab_mcr	1.405	0.007	67.18	0.000	1.391	1.419
2015#aged_mcr	2.068	0.020	73.98	0.000	2.029	2.108

	Odds Ratio	Std. Err.	z	P>z	[95% Conf.	Interval]
2015#disab_mcr	1.517	0.008	84.20	0.000	1.502	1.532
2016#aged_mcr	2.133	0.020	79.19	0.000	2.093	2.173
2016#disab_mcr						
qrtr#bene_cat						
2#aged_mcr	1.029	0.005	6.47	0.000	1.020	1.038
2#disab_mcr	1.045	0.008	5.83	0.000	1.029	1.060
3#aged_mcr	1.047	0.005	9.68	0.000	1.037	1.057
3#disab_mcr	1.079	0.009	9.22	0.000	1.062	1.096
4#aged_mcr	1.169	0.006	32.04	0.000	1.157	1.180
4#disab_mcr	1.156	0.010	16.98	0.000	1.137	1.176
yr#qrtr#bene_cat						
2008#2#aged_mcr	0.995	0.006	-0.78	0.437	0.984	1.007
2008#2#disab_mcr	0.987	0.010	-1.25	0.210	0.968	1.007
2008#3#aged_mcr	1.007	0.007	1.02	0.307	0.994	1.020
2008#3#disab_mcr	0.992	0.011	-0.73	0.462	0.970	1.014
2008#4#aged_mcr	0.902	0.006	-15.09	0.000	0.890	0.914
2008#4#disab_mcr	0.944	0.011	-4.88	0.000	0.922	0.966
2009#2#aged_mcr	1.015	0.006	2.75	0.006	1.004	1.026
2009#2#disab_mcr	1.008	0.009	0.87	0.383	0.990	1.027
2009#3#aged_mcr	1.018	0.006	2.97	0.003	1.006	1.030
2009#3#disab_mcr	0.997	0.010	-0.33	0.738	0.977	1.017
2009#4#aged_mcr	0.905	0.006	-16.22	0.000	0.894	0.916
2009#4#disab_mcr	0.934	0.010	-6.45	0.000	0.915	0.954
2010#2#aged_mcr	1.013	0.005	2.52	0.012	1.003	1.024
2010#2#disab_mcr	0.975	0.009	-2.84	0.004	0.959	0.992
2010#3#aged_mcr	0.995	0.006	-0.94	0.347	0.984	1.006
2010#3#disab_mcr	0.959	0.009	-4.31	0.000	0.941	0.978
2010#4#aged_mcr	0.889	0.005	-20.23	0.000	0.879	0.899
2010#4#disab_mcr	0.891	0.009	-11.56	0.000	0.874	0.908
2011#2#aged_mcr	1.003	0.005	0.56	0.573	0.993	1.013
2011#2#disab_mcr	0.965	0.008	-4.12	0.000	0.949	0.982
2011#3#aged_mcr	0.973	0.005	-4.97	0.000	0.962	0.983
2011#3#disab_mcr	0.929	0.009	-7.76	0.000	0.912	0.947
2011#4#aged_mcr	0.863	0.005	-25.73	0.000	0.853	0.873
2011#4#disab_mcr	0.866	0.009	-14.62	0.000	0.850	0.883
2012#2#aged_mcr	1.001	0.005	0.19	0.847	0.991	1.011
	0.966	0.008	-4.06	0.000	0.951	0.982

	Odds Ratio	Std. Err.	z	P>z	[95% Conf.	Interval]
2012#2#disab_mcr	0.987	0.005	-2.32	0.020	0.977	0.998
2012#3#aged_mcr	0.945	0.009	-6.08	0.000	0.928	0.963
2012#3#disab_mcr	0.874	0.005	-23.83	0.000	0.865	0.884
2012#4#aged_mcr	0.862	0.008	-15.46	0.000	0.846	0.878
2012#4#disab_mcr	1.002	0.005	0.35	0.724	0.992	1.012
2013#2#aged_mcr	0.970	0.008	-3.65	0.000	0.954	0.986
2013#2#disab_mcr	0.986	0.005	-2.50	0.012	0.976	0.997
2013#3#aged_mcr	0.936	0.009	-7.24	0.000	0.919	0.953
2013#3#disab_mcr	0.874	0.005	-24.26	0.000	0.864	0.883
2013#4#aged_mcr	0.859	0.008	-15.96	0.000	0.844	0.876
2013#4#disab_mcr	1.010	0.005	1.88	0.059	1.000	1.020
2014#2#aged_mcr	0.949	0.008	-6.31	0.000	0.933	0.964
2014#2#disab_mcr	1.022	0.006	4.00	0.000	1.011	1.033
2014#3#aged_mcr	0.948	0.009	-5.84	0.000	0.931	0.965
2014#3#disab_mcr	0.905	0.005	-17.89	0.000	0.895	0.915
2014#4#aged_mcr	0.871	0.008	-14.50	0.000	0.855	0.887
2014#4#disab_mcr	0.972	0.005	-5.72	0.000	0.962	0.981
2015#2#aged_mcr	0.934	0.008	-8.19	0.000	0.919	0.949
2015#2#disab_mcr	0.915	0.005	-16.37	0.000	0.905	0.925
2015#3#aged_mcr	0.869	0.008	-15.27	0.000	0.854	0.885
2015#3#disab_mcr	0.801	0.004	-39.92	0.000	0.792	0.810
2015#4#aged_mcr	0.789	0.008	-24.84	0.000	0.775	0.804
2015#4#disab_mcr	0.959	0.005	-8.60	0.000	0.949	0.968
2016#2#aged_mcr	0.942	0.008	-7.35	0.000	0.927	0.957
2016#2#disab_mcr	0.953	0.005	-9.00	0.000	0.943	0.963
2016#3#aged_mcr	0.925	0.008	-8.74	0.000	0.909	0.941
2016#3#disab_mcr	0.830	0.005	-34.24	0.000	0.822	0.839
2016#4#aged_mcr	0.822	0.008	-21.18	0.000	0.807	0.837
2016#4#disab_mcr						
Coverage cohort (first year of insurance coverage)						
pre-2007	0.965	0.002	-21.78	0.000	0.962	0.968
2007	0.991	0.002	-4.80	0.000	0.988	0.995
2008	0.917	0.002	-46.06	0.000	0.913	0.920
2009	0.948	0.002	-28.36	0.000	0.945	0.952
2010	0.952	0.002	-25.34	0.000	0.948	0.955
2011	0.885	0.002	-59.83	0.000	0.882	0.889
2012	0.926	0.002	-37.53	0.000	0.922	0.929

	Odds Ratio	Std. Err.	z	P>z	[95% Conf.	Interval]
2013	0.871	0.002	-65.73	0.000	0.868	0.875
2014	0.812	0.002	-99.68	0.000	0.809	0.815
2015	0.982	0.002	-7.76	0.000	0.977	0.986
2016						
1.female	1.331	0.001	323.36	0.000	1.328	1.333
Age						
0-18	0.150	0.000	1339.31	0.000	0.150	0.151
19-34	0.739	0.001	-272.66	0.000	0.737	0.740
35-44	(ref)					
45-54	1.205	0.001	152.79	0.000	1.202	1.208
55-64	1.328	0.002	202.68	0.000	1.324	1.332
65-74	1.459	0.004	139.65	0.000	1.451	1.466
75+	1.452	0.005	111.08	0.000	1.442	1.461
unk	0.659	0.125	-2.19	0.028	0.454	0.956
Race/ethnicity						
White	(ref)					
Black	1.016	0.001	10.88	0.000	1.013	1.019
Hispanic	0.772	0.001	-172.64	0.000	0.770	0.774
Asian	0.467	0.001	-292.09	0.000	0.465	0.469
Unknown/other	0.797	0.002	-117.62	0.000	0.794	0.800
Census Division						
New England	(ref)					
Mid Atlantic	0.871	0.003	-44.41	0.000	0.865	0.876
East North Central	1.281	0.004	88.76	0.000	1.274	1.288
West North Central	1.097	0.003	31.82	0.000	1.091	1.104
South Atlantic	1.422	0.004	131.00	0.000	1.414	1.429
East South Central	1.897	0.006	198.77	0.000	1.885	1.909
West South Central	1.589	0.004	167.02	0.000	1.581	1.598
Mountain	1.462	0.004	129.09	0.000	1.454	1.471
Pacific	1.189	0.004	56.07	0.000	1.182	1.196
Unk/Other	0.269	0.003	-118.98	0.000	0.263	0.275
	1.060	0.002	37.81	0.000	1.057	1.064
_cons	0.062	0.000	-933.35	0.000	0.061	0.062

Appendix 8: Predictive margins used to create Figures 1 and 2 in main text

Average daily dose										
		Aged Medicare			Commercial			Disabled Medicare		
Year	Quarter	MME	lower CI	upper CI	MME	lower CI	upper CI	MME	lower CI	upper CI
2007	Q1	20.06	19.68	20.45	14.60	14.38	14.82	52.69	51.09	54.28
	Q2	20.12	19.73	20.50	14.92	14.70	15.14	53.54	51.94	55.15
	Q3	20.06	19.69	20.44	14.98	14.76	15.19	52.22	50.73	53.71
	Q4	20.24	19.88	20.59	15.50	15.28	15.72	53.39	51.92	54.85
2008	Q1	20.73	20.37	21.08	15.17	14.96	15.38	56.26	54.80	57.71
	Q2	21.04	20.69	21.39	15.66	15.43	15.88	58.82	57.36	60.27
	Q3	21.26	20.92	21.61	15.75	15.53	15.97	59.01	57.62	60.40
	Q4	21.83	21.48	22.19	16.40	16.17	16.63	60.73	59.33	62.14
2009	Q1	21.10	20.80	21.41	16.38	16.16	16.60	60.26	59.06	61.46
	Q2	20.25	19.97	20.53	16.49	16.26	16.71	60.19	59.08	61.31
	Q3	19.85	19.58	20.11	16.74	16.51	16.96	59.69	58.63	60.75
	Q4	19.18	18.94	19.42	17.33	17.09	17.56	59.69	58.66	60.73
2010	Q1	19.44	19.22	19.65	17.52	17.28	17.77	61.28	60.31	62.25
	Q2	19.47	19.26	19.68	17.65	17.41	17.90	62.25	61.30	63.19
	Q3	19.38	19.17	19.58	17.44	17.20	17.68	61.13	60.23	62.03
	Q4	18.93	18.74	19.13	17.46	17.23	17.70	61.92	61.03	62.81
2011	Q1	18.52	18.32	18.72	17.05	16.81	17.28	64.37	63.48	65.25
	Q2	18.44	18.24	18.63	17.13	16.89	17.37	65.78	64.89	66.67
	Q3	18.28	18.09	18.47	16.91	16.67	17.14	64.36	63.51	65.20
	Q4	18.33	18.14	18.52	16.99	16.75	17.22	64.11	63.29	64.94
2012	Q1	19.01	18.82	19.21	16.59	16.36	16.82	65.81	65.00	66.62
	Q2	19.15	18.96	19.34	16.88	16.64	17.11	66.59	65.80	67.39

Average daily dose

		Aged Medicare			Commercial			Disabled Medicare		
Year	Quarter	MME	lower CI	upper CI	MME	lower CI	upper CI	MME	lower CI	upper CI
	Q3	18.83	18.64	19.01	16.75	16.51	16.98	64.87	64.11	65.64
	Q4	18.88	18.70	19.06	16.90	16.66	17.13	65.09	64.34	65.84
2013	Q1	19.38	19.20	19.56	17.06	16.82	17.30	65.66	64.92	66.40
	Q2	18.86	18.69	19.03	16.95	16.71	17.19	63.75	63.04	64.45
	Q3	18.59	18.42	18.76	16.88	16.64	17.12	61.61	60.94	62.28
	Q4	18.65	18.49	18.82	17.01	16.77	17.25	61.39	60.73	62.05
2014	Q1	19.96	19.78	20.14	17.24	16.98	17.49	63.06	62.35	63.78
	Q2	19.56	19.39	19.74	17.31	17.05	17.57	63.01	62.30	63.72
	Q3	19.29	19.12	19.47	16.99	16.74	17.25	61.74	61.05	62.43
	Q4	19.49	19.31	19.67	16.89	16.63	17.15	62.33	61.63	63.02
2015	Q1	20.14	19.95	20.33	17.06	16.80	17.32	63.54	62.82	64.27
	Q2	19.78	19.60	19.96	17.18	16.92	17.44	62.54	61.83	63.25
	Q3	19.49	19.31	19.67	16.77	16.52	17.02	60.88	60.19	61.57
	Q4	19.70	19.52	19.88	16.93	16.68	17.18	61.46	60.76	62.15
2016	Q1	20.20	20.02	20.38	16.69	16.45	16.94	56.37	55.79	56.95
	Q2	20.72	20.54	20.90	17.20	16.95	17.45	57.71	57.12	58.30
	Q3	20.27	20.09	20.45	16.80	16.56	17.05	55.95	55.38	56.53
	Q4	20.21	20.04	20.39	16.71	16.47	16.96	55.89	55.32	56.46

Opioid Use Prevalence

		Aged Medicare			Commercial			Disabled Medicare		
Year	Quarter	Proportion using opioids in quarter	lower CI	upper CI	Proportion using opioids in quarter	lower CI	upper CI	Proportion using opioids in quarter	lower CI	upper CI
2007	Q1	0.11	0.11	0.11	0.06	0.06	0.06	0.26	0.26	0.26
	Q2	0.12	0.12	0.12	0.06	0.06	0.06	0.27	0.27	0.27
	Q3	0.12	0.12	0.12	0.07	0.07	0.07	0.27	0.27	0.27
	Q4	0.13	0.13	0.13	0.07	0.07	0.07	0.29	0.29	0.29
2008	Q1	0.12	0.12	0.12	0.07	0.07	0.07	0.29	0.29	0.29
	Q2	0.12	0.12	0.12	0.07	0.07	0.07	0.29	0.29	0.29
	Q3	0.13	0.13	0.13	0.07	0.07	0.07	0.30	0.30	0.30
	Q4	0.13	0.13	0.13	0.07	0.07	0.07	0.31	0.31	0.31
2009	Q1	0.12	0.12	0.12	0.07	0.07	0.07	0.33	0.33	0.33
	Q2	0.13	0.13	0.13	0.07	0.07	0.07	0.34	0.34	0.34
	Q3	0.13	0.13	0.13	0.07	0.07	0.07	0.35	0.35	0.35
	Q4	0.13	0.13	0.13	0.07	0.07	0.07	0.35	0.35	0.35
2010	Q1	0.14	0.14	0.14	0.07	0.07	0.07	0.36	0.36	0.36
	Q2	0.14	0.14	0.14	0.07	0.07	0.07	0.36	0.36	0.36
	Q3	0.14	0.14	0.14	0.07	0.07	0.07	0.37	0.37	0.37
	Q4	0.15	0.15	0.15	0.07	0.07	0.07	0.37	0.37	0.37
2011	Q1	0.15	0.15	0.15	0.07	0.07	0.07	0.39	0.39	0.39
	Q2	0.15	0.15	0.15	0.07	0.07	0.07	0.39	0.39	0.39
	Q3	0.15	0.15	0.15	0.07	0.07	0.07	0.39	0.39	0.39
	Q4	0.15	0.15	0.15	0.07	0.07	0.07	0.39	0.39	0.39
2012	Q1	0.15	0.15	0.15	0.07	0.07	0.07	0.40	0.40	0.40
	Q2	0.15	0.15	0.15	0.07	0.07	0.07	0.41	0.41	0.41

Opioid Use Prevalence

		Aged Medicare			Commercial			Disabled Medicare		
Year	Quarter	Proportion using opioids in quarter	lower CI	upper CI	Proportion using opioids in quarter	lower CI	upper CI	Proportion using opioids in quarter	lower CI	upper CI
	Q3	0.15	0.15	0.15	0.07	0.07	0.07	0.41	0.41	0.41
	Q4	0.15	0.15	0.15	0.07	0.07	0.07	0.41	0.41	0.41
2013	Q1	0.15	0.15	0.15	0.07	0.07	0.07	0.41	0.41	0.41
	Q2	0.15	0.15	0.15	0.07	0.07	0.07	0.41	0.41	0.41
	Q3	0.15	0.15	0.15	0.07	0.07	0.07	0.41	0.41	0.41
	Q4	0.15	0.15	0.15	0.07	0.07	0.07	0.41	0.41	0.41
2014	Q1	0.14	0.14	0.14	0.06	0.06	0.07	0.40	0.40	0.40
	Q2	0.15	0.15	0.15	0.07	0.07	0.07	0.41	0.41	0.41
	Q3	0.15	0.15	0.15	0.06	0.06	0.06	0.41	0.40	0.41
	Q4	0.15	0.15	0.15	0.06	0.06	0.06	0.40	0.40	0.40
2015	Q1	0.14	0.14	0.14	0.06	0.06	0.06	0.40	0.40	0.40
	Q2	0.14	0.14	0.14	0.06	0.06	0.06	0.41	0.41	0.41
	Q3	0.14	0.14	0.14	0.06	0.06	0.06	0.41	0.41	0.41
	Q4	0.14	0.14	0.14	0.06	0.06	0.06	0.41	0.41	0.41
2016	Q1	0.15	0.15	0.15	0.06	0.06	0.06	0.40	0.40	0.40
	Q2	0.15	0.15	0.15	0.06	0.06	0.06	0.40	0.40	0.40
	Q3	0.15	0.15	0.15	0.06	0.06	0.06	0.39	0.39	0.39
	Q4	0.14	0.14	0.14	0.06	0.06	0.06	0.39	0.38	0.39

Average daily dose by age (MME)

Year/ Quarter		Commercial							Aged Medicare		Disabled Medicare			
		0-18	19-34	35-44	45-54	55-64	65-74	75+	65-74	75+	19-34	35-44	45-54	55-64
2007	Q1	3.48	8.78	15.40	20.74	18.95	17.77	19.00	20.68	18.98	59.51	68.84	65.17	45.60
	Q2	3.55	9.20	16.03	21.25	19.22	18.37	18.96	20.91	19.36	59.12	72.29	67.03	46.39
	Q3	3.39	9.52	16.45	21.47	19.33	18.49	19.67	21.30	19.48	56.61	72.05	66.71	45.57
	Q4	3.60	10.27	17.01	21.79	19.34	19.09	19.27	21.88	20.27	60.83	70.94	70.05	45.88
2008	Q1	3.57	9.56	16.02	21.30	19.11	18.55	19.17	22.35	19.43	56.91	73.96	71.59	48.85
	Q2	3.63	10.13	16.56	21.94	19.47	18.47	18.71	23.02	19.58	59.95	77.77	74.35	50.55
	Q3	3.40	10.49	16.95	22.21	19.65	18.44	19.16	23.63	20.16	61.64	78.43	75.47	52.26
	Q4	3.51	11.42	17.51	22.60	19.95	18.39	17.68	24.36	20.71	60.38	79.71	78.01	53.22
2009	Q1	3.29	10.69	16.82	22.30	20.31	18.25	18.18	22.94	19.55	56.33	75.52	76.89	52.38
	Q2	3.17	11.14	17.20	22.69	20.27	18.42	18.12	22.37	18.76	58.67	74.80	78.46	52.21
	Q3	2.98	11.70	17.90	23.02	20.67	18.53	18.05	22.24	18.56	59.03	76.04	78.55	51.97
	Q4	3.18	12.60	18.36	23.09	20.74	18.63	16.86	21.68	17.85	61.04	78.40	78.08	51.22
2010	Q1	3.11	12.04	18.10	22.89	21.15	17.83	15.96	21.78	17.81	61.45	76.86	77.62	53.18
	Q2	3.14	12.48	18.58	23.30	21.19	17.52	17.51	22.31	18.13	63.64	79.23	79.25	54.78
	Q3	3.03	12.60	18.81	23.18	21.08	17.36	16.64	22.40	18.28	62.17	78.31	78.94	54.35
	Q4	3.21	12.90	18.74	22.59	20.28	16.94	15.79	21.56	17.51	64.13	79.00	79.96	54.27
2011	Q1	3.06	11.59	17.83	21.50	19.78	15.76	14.81	20.38	15.34	57.72	78.40	80.14	55.99
	Q2	3.00	11.90	18.10	21.68	19.83	15.76	14.45	20.65	15.37	61.86	82.50	82.85	57.58
	Q3	2.85	11.87	18.20	21.65	19.71	15.82	14.11	20.69	15.45	59.66	80.41	81.52	57.01
	Q4	3.07	12.44	18.17	21.62	19.49	16.09	14.12	20.62	15.61	61.40	80.96	81.25	56.44
2012	Q1	2.95	11.27	17.56	21.07	20.02	15.95	14.58	21.68	15.53	60.92	80.27	81.66	58.54
	Q2	3.00	11.60	17.93	21.52	20.21	16.26	14.42	21.92	15.58	61.17	79.88	82.54	59.42

Average daily dose by age (MME)

		Commercial							Aged Medicare		Disabled Medicare			
Year/ Quarter		0-18	19-34	35-44	45-54	55-64	65-74	75+	65-74	75+	19-34	35-44	45-54	55-64
	Q3	2.89	11.64	18.11	21.50	20.13	16.44	13.96	21.70	15.59	62.75	79.08	80.75	58.45
	Q4	3.01	12.18	17.95	21.49	19.76	16.19	13.24	21.64	15.71	63.50	79.77	81.29	58.48
2013	Q1	3.04	11.41	17.84	21.36	20.48	16.43	13.96	22.09	15.55	59.62	77.99	79.24	59.30
	Q2	2.99	11.68	18.12	21.46	20.17	16.48	13.77	21.71	15.38	59.17	76.80	77.71	58.32
	Q3	3.14	11.75	18.39	21.31	20.08	16.44	13.91	21.47	15.50	57.35	75.16	76.03	57.02
	Q4	3.65	12.17	18.23	21.17	19.73	15.73	13.95	21.43	15.61	58.95	75.47	76.00	56.59
2014	Q1	3.92	11.22	18.21	21.18	20.77	17.22	13.67	22.99	16.11	53.98	73.88	74.65	58.50
	Q2	4.07	11.35	18.48	21.20	21.05	17.48	14.26	22.75	15.95	54.27	74.58	75.33	59.21
	Q3	3.76	10.75	18.19	21.22	20.93	17.50	14.23	22.56	16.01	54.88	73.91	74.13	58.67
	Q4	3.77	11.03	18.28	20.98	20.52	17.72	14.51	22.73	16.22	57.62	75.58	74.68	58.88
2015	Q1	3.81	10.14	17.85	20.85	21.17	17.73	15.41	23.30	16.13	56.06	73.50	73.71	59.44
	Q2	3.87	10.35	18.30	21.30	21.37	18.10	15.33	23.12	16.06	55.57	72.63	73.54	58.94
	Q3	3.58	10.35	18.26	21.20	21.03	17.64	15.57	22.94	16.04	54.99	71.60	72.15	58.26
	Q4	3.86	10.84	18.28	21.07	20.86	17.59	15.71	23.11	16.24	56.20	71.94	72.87	58.82
2016	Q1	3.79	9.82	17.77	21.01	21.13	18.02	14.14	24.12	16.27	46.70	64.11	65.66	55.58
	Q2	3.78	10.35	18.64	21.90	21.63	18.38	14.03	24.82	16.57	45.44	65.07	67.26	56.93
	Q3	3.51	10.42	18.53	21.65	21.26	18.26	14.30	24.49	16.50	44.71	63.78	65.85	55.89
	Q4	3.73	10.74	18.40	21.08	20.71	17.60	13.61	24.30	16.53	45.43	64.63	65.81	55.76

Opioid use prevalence by age (proportion using in quarter)

		Commercial							Aged Medicare		Disabled Medicare			
Year/ Quarter		0-18	19-34	35-44	45-54	55-64	65-74	75+	65-74	75+	19-34	35-44	45-54	55-64
2007	Q1	0.01	0.07	0.08	0.10	0.10	0.11	0.11	0.11	0.12	0.19	0.26	0.31	0.26
	Q2	0.01	0.07	0.08	0.10	0.10	0.11	0.11	0.11	0.13	0.19	0.27	0.31	0.27
	Q3	0.02	0.07	0.08	0.10	0.10	0.11	0.11	0.12	0.13	0.21	0.28	0.32	0.28
	Q4	0.01	0.07	0.08	0.10	0.11	0.11	0.11	0.13	0.14	0.21	0.30	0.33	0.29
2008	Q1	0.01	0.07	0.09	0.10	0.11	0.11	0.11	0.12	0.13	0.23	0.29	0.33	0.29
	Q2	0.01	0.07	0.09	0.10	0.11	0.12	0.12	0.13	0.13	0.23	0.29	0.34	0.30
	Q3	0.02	0.07	0.09	0.10	0.11	0.12	0.12	0.13	0.14	0.23	0.31	0.35	0.31
	Q4	0.01	0.07	0.09	0.10	0.11	0.12	0.12	0.13	0.14	0.24	0.32	0.35	0.31
2009	Q1	0.01	0.07	0.09	0.10	0.11	0.12	0.12	0.13	0.13	0.24	0.32	0.37	0.33
	Q2	0.01	0.07	0.09	0.10	0.11	0.12	0.12	0.13	0.14	0.25	0.34	0.39	0.34
	Q3	0.02	0.07	0.09	0.10	0.11	0.12	0.12	0.14	0.14	0.25	0.35	0.40	0.35
	Q4	0.02	0.07	0.09	0.11	0.12	0.12	0.12	0.14	0.14	0.25	0.36	0.40	0.35
2010	Q1	0.01	0.07	0.09	0.10	0.11	0.12	0.12	0.14	0.14	0.25	0.35	0.40	0.36
	Q2	0.01	0.07	0.09	0.10	0.12	0.12	0.13	0.15	0.15	0.25	0.36	0.41	0.37
	Q3	0.02	0.07	0.09	0.10	0.12	0.12	0.13	0.15	0.15	0.27	0.37	0.42	0.37
	Q4	0.02	0.07	0.09	0.11	0.12	0.12	0.13	0.15	0.15	0.26	0.37	0.42	0.37
2011	Q1	0.01	0.07	0.09	0.10	0.12	0.12	0.13	0.15	0.15	0.26	0.38	0.44	0.39
	Q2	0.01	0.07	0.09	0.10	0.12	0.12	0.13	0.15	0.15	0.26	0.38	0.44	0.39
	Q3	0.02	0.07	0.09	0.10	0.12	0.12	0.13	0.15	0.15	0.27	0.38	0.44	0.39
	Q4	0.02	0.07	0.09	0.10	0.12	0.13	0.13	0.15	0.15	0.27	0.39	0.45	0.39
2012	Q1	0.01	0.07	0.09	0.10	0.12	0.12	0.13	0.15	0.15	0.27	0.39	0.45	0.40
	Q2	0.01	0.07	0.09	0.10	0.12	0.12	0.13	0.15	0.15	0.27	0.39	0.45	0.41
	Q3	0.02	0.07	0.08	0.10	0.12	0.12	0.12	0.15	0.15	0.26	0.39	0.45	0.40

Opioid use prevalence by age (proportion using in quarter)

		Commercial							Aged Medicare		Disabled Medicare			
Year/ Quarter		0-18	19-34	35-44	45-54	55-64	65-74	75+	65-74	75+	19-34	35-44	45-54	55-64
	Q4	0.01	0.06	0.09	0.10	0.12	0.12	0.13	0.15	0.15	0.27	0.39	0.45	0.40
2013	Q1	0.01	0.06	0.08	0.10	0.11	0.12	0.12	0.15	0.15	0.25	0.38	0.45	0.41
	Q2	0.01	0.06	0.08	0.10	0.11	0.12	0.12	0.15	0.15	0.25	0.38	0.45	0.41
	Q3	0.01	0.06	0.08	0.10	0.11	0.12	0.13	0.15	0.15	0.26	0.38	0.45	0.41
	Q4	0.01	0.06	0.08	0.10	0.12	0.12	0.12	0.15	0.15	0.26	0.38	0.45	0.41
2014	Q1	0.01	0.06	0.08	0.10	0.11	0.11	0.12	0.15	0.14	0.23	0.37	0.44	0.40
	Q2	0.01	0.06	0.08	0.10	0.11	0.12	0.12	0.15	0.15	0.24	0.37	0.44	0.41
	Q3	0.01	0.06	0.08	0.09	0.11	0.12	0.12	0.15	0.15	0.24	0.37	0.44	0.40
	Q4	0.01	0.05	0.08	0.09	0.11	0.12	0.12	0.14	0.14	0.23	0.36	0.43	0.39
2015	Q1	0.01	0.05	0.07	0.09	0.10	0.11	0.11	0.14	0.13	0.21	0.36	0.43	0.40
	Q2	0.01	0.05	0.08	0.09	0.11	0.11	0.12	0.14	0.14	0.22	0.36	0.43	0.40
	Q3	0.01	0.05	0.08	0.09	0.11	0.11	0.12	0.14	0.14	0.22	0.36	0.43	0.40
	Q4	0.01	0.05	0.08	0.10	0.11	0.12	0.12	0.14	0.14	0.22	0.36	0.43	0.40
2016	Q1	0.01	0.05	0.07	0.09	0.11	0.11	0.11	0.15	0.14	0.21	0.35	0.42	0.40
	Q2	0.01	0.05	0.07	0.09	0.11	0.11	0.11	0.15	0.14	0.21	0.35	0.42	0.40
	Q3	0.01	0.05	0.07	0.09	0.10	0.11	0.11	0.15	0.14	0.21	0.35	0.42	0.40
	Q4	0.01	0.05	0.07	0.09	0.11	0.11	0.11	0.14	0.14	0.20	0.33	0.41	0.39

Appendix 9: Trends in opioids filled

Figure A1: Aged Medicare volume trends by active ingredient: MME per 1000 person-years (unadjusted)

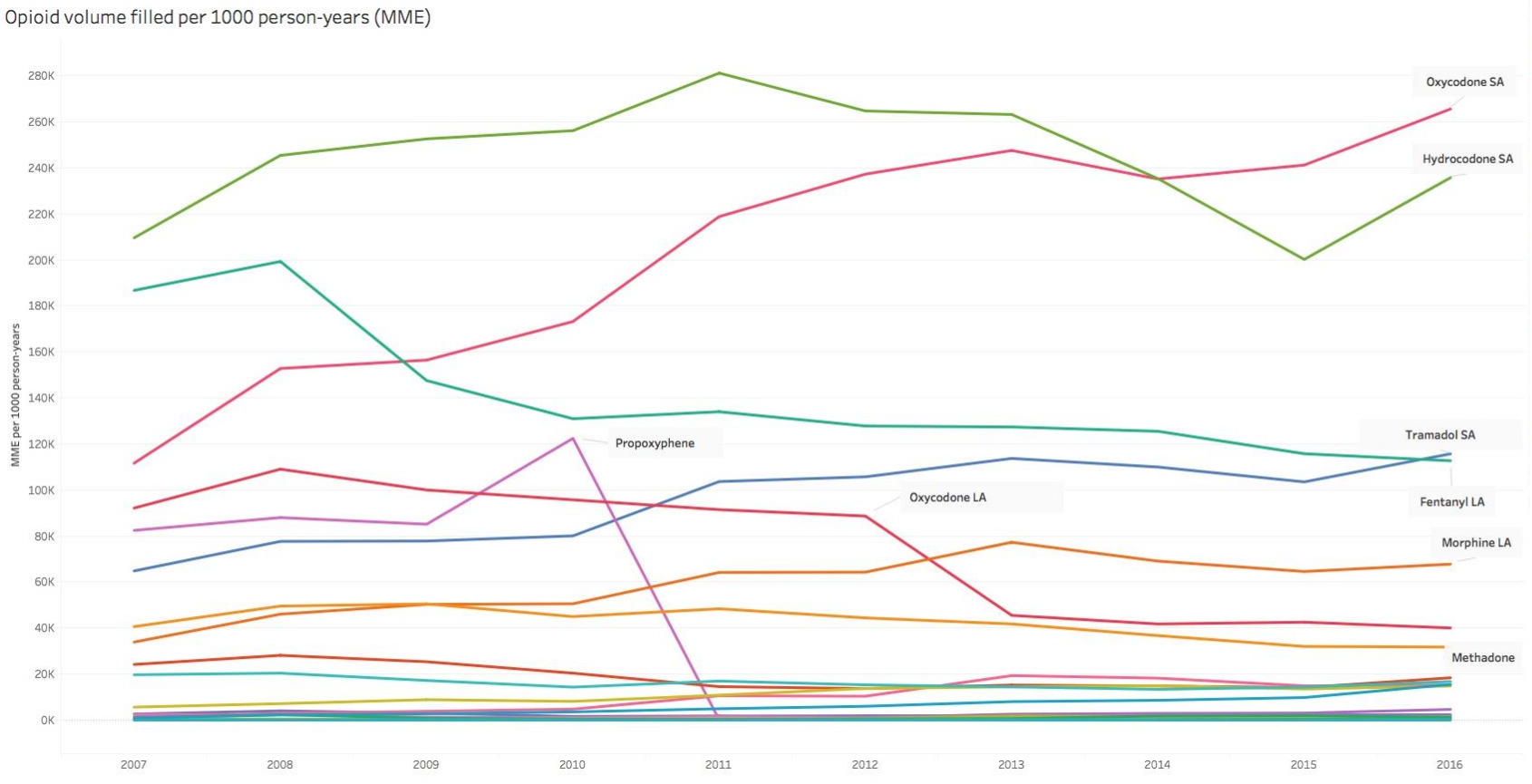


Figure A2: Aged Medicare fill trends by active ingredient: fills per 1000 person-years (unadjusted)

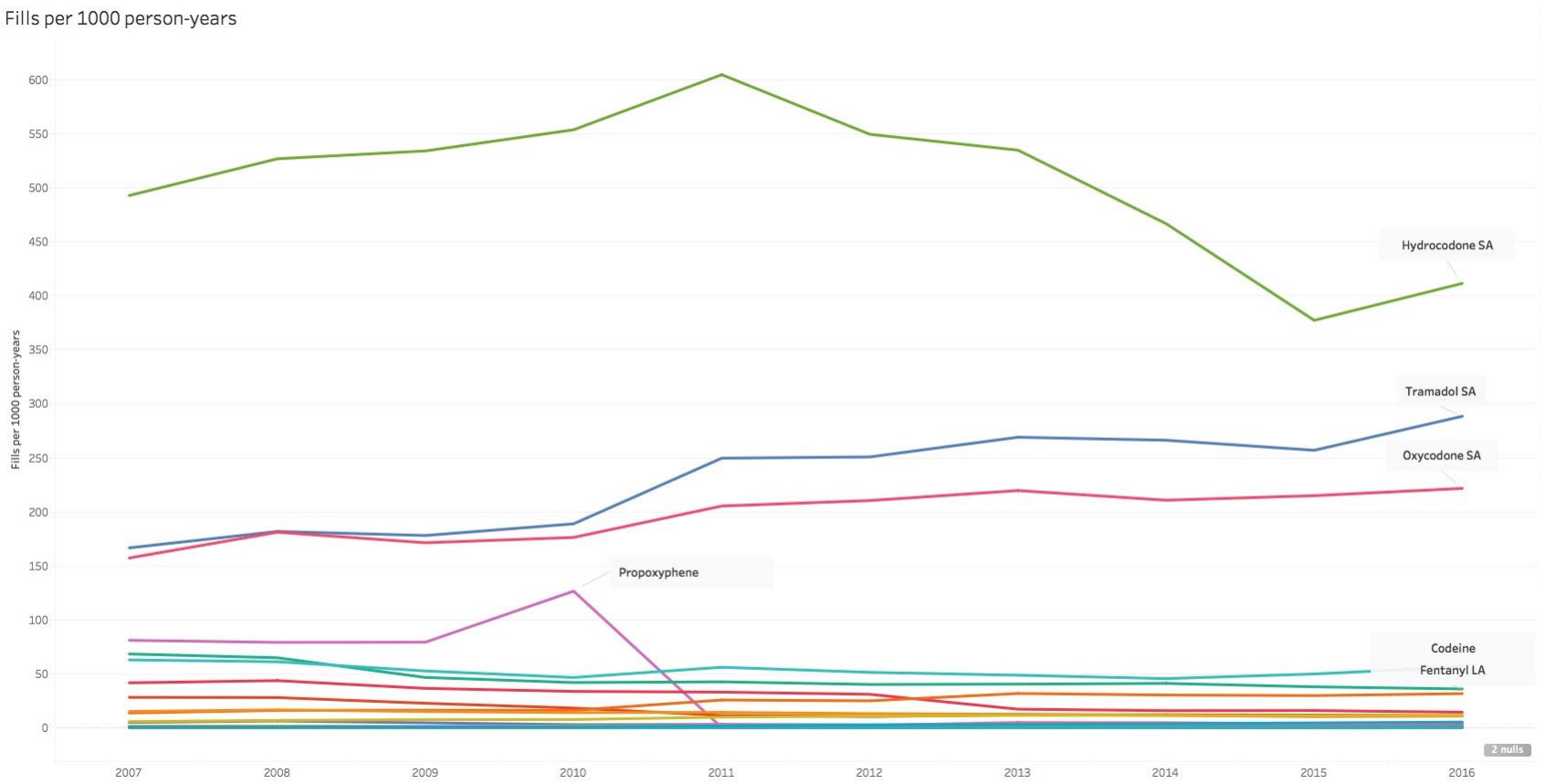


Figure A3: Commercial volume trends by active ingredient: MME per 1000 person-years (unadjusted)

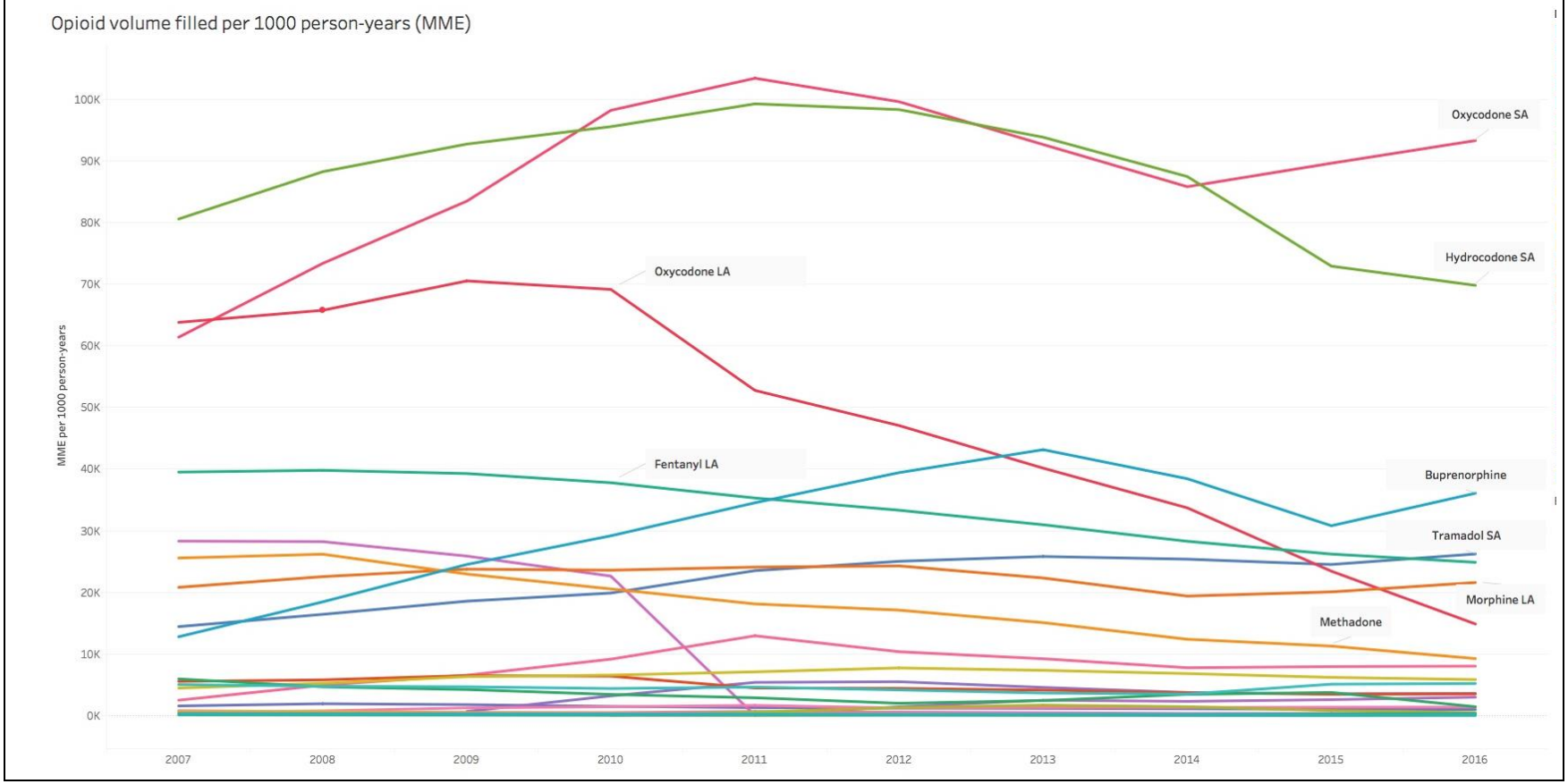


Figure A4: Commercial fill trends by active ingredient: Fills per 1000 person-years (unadjusted)

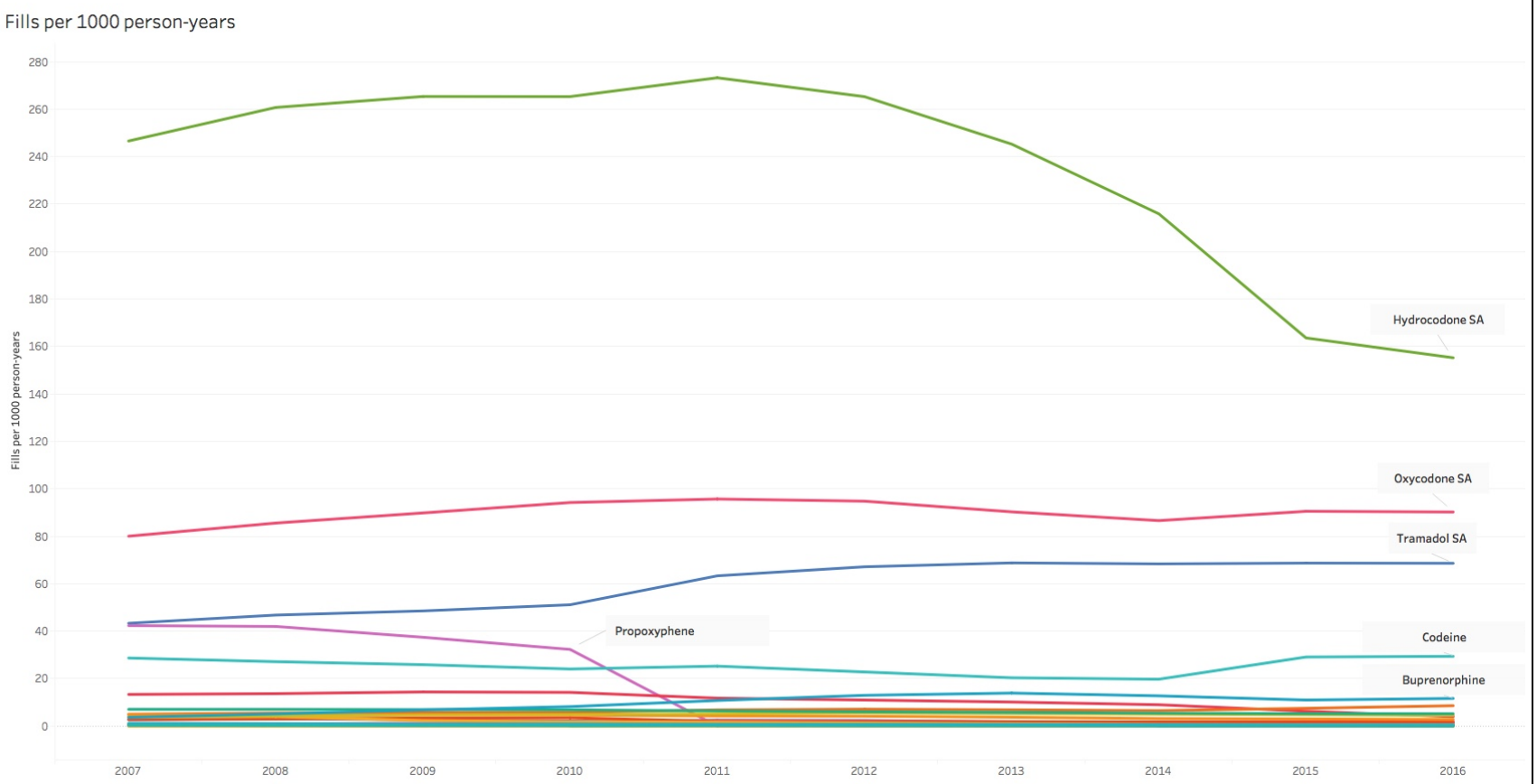


Figure A5: Disabled Medicare volume trends by active ingredient: MME per 1000 person-years (unadjusted)

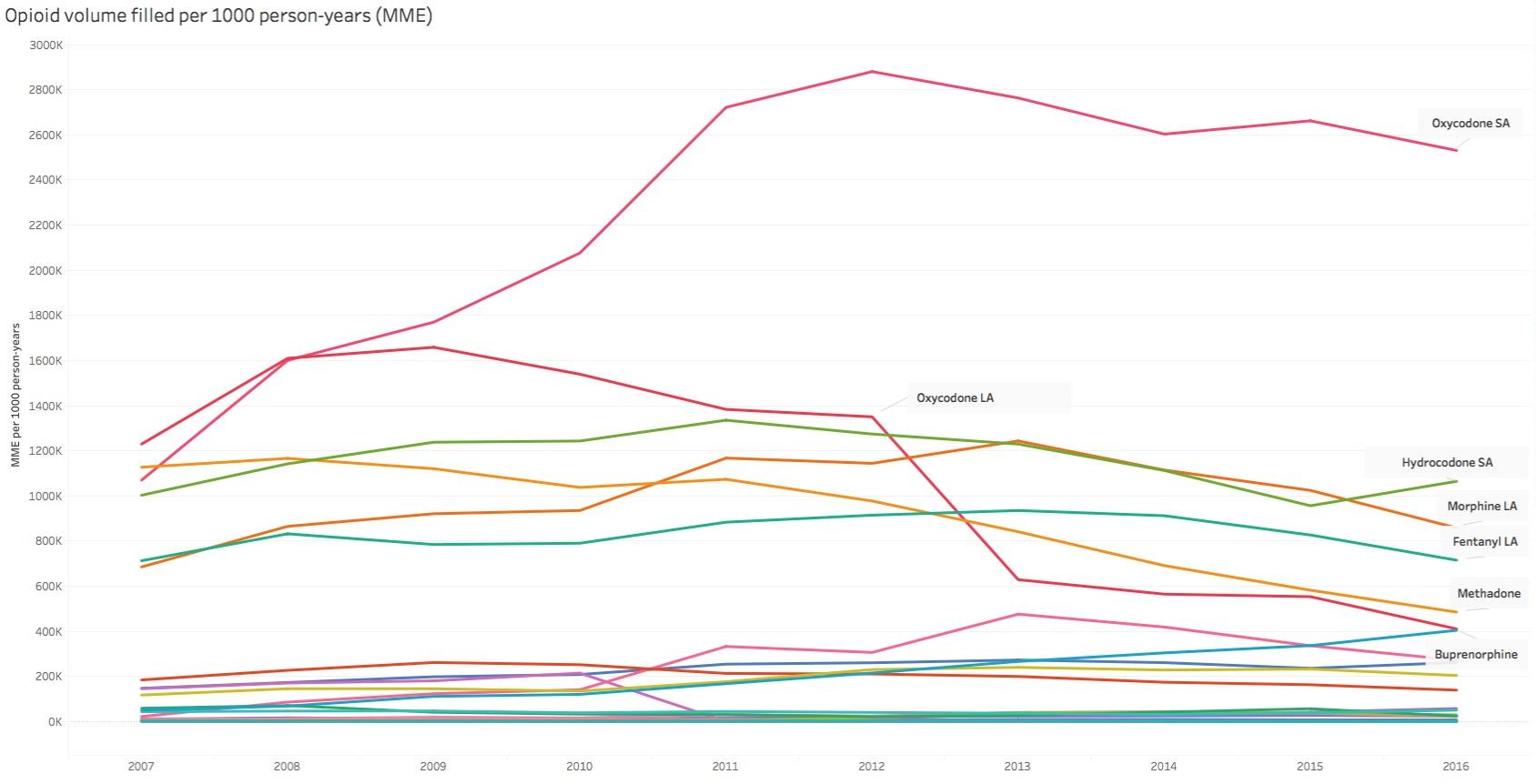


Figure A6: Disabled Medicare fill trends by active ingredient: Fills per 1000 person-years (unadjusted)

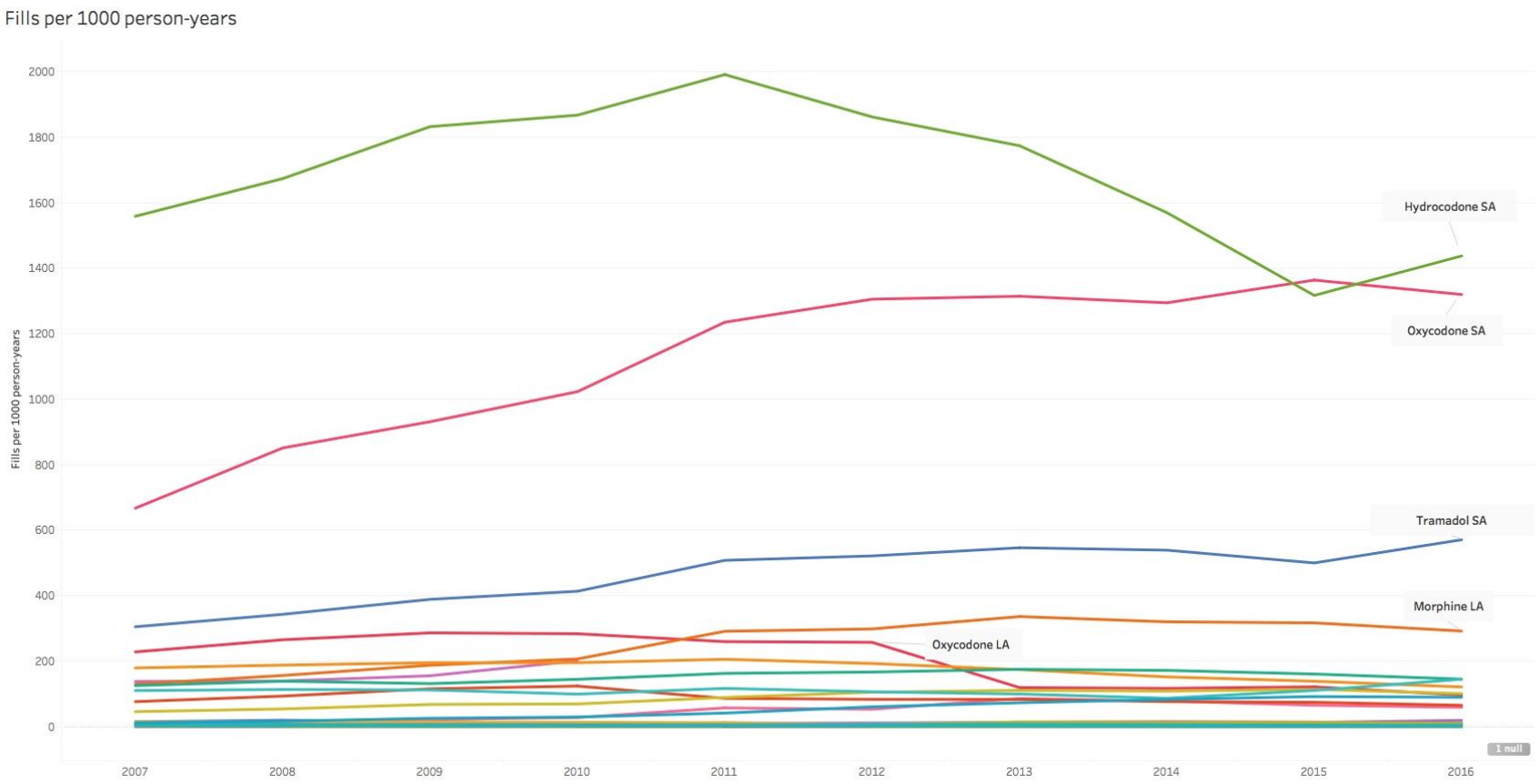


Table A6: Number of fills and volume of opioids filled by active ingredient and beneficiary population (data for Figures A1 through A6)

		Commercial		Aged Medicare		Disabled Medicare	
DRUG		Fills per 1000 person-years	MME per 1000 person-years	Fills per 1000 person-years	MME per 1000 person-years	Fills per 1000 person-years	MME per 1000 person-years
Buprenorphine	2007	4	12,784	0	913	12	49,886
	2008	5	18,452	1	2,158	17	68,213
	2009	7	24,520	1	2,685	26	111,308
	2010	8	29,177	1	3,502	29	120,234
	2011	11	34,538	2	4,869	42	167,640
	2012	13	39,428	2	5,950	61	215,081
	2013	14	43,154	3	7,963	73	266,016
	2014	13	38,440	4	8,543	83	304,108
	2015	11	30,804	4	9,737	92	336,349
	2016	12	36,088	5	15,426	90	404,104
Butorphanol	2007	1	347	0	88	9	3,021
	2008	1	330	0	67	7	2,745
	2009	1	300	0	85	7	2,688
	2010	1	262	0	72	6	1,885
	2011	1	233	0	107	6	1,759
	2012	1	210	0	160	7	2,304
	2013	1	208	0	155	7	2,841
	2014	1	186	0	119	6	2,517
	2015	1	182	0	123	4	1,420
	2016	1	178	0	145	5	1,294
Codeine	2007	29	5,018	63	19,656	110	43,202
	2008	27	4,751	61	20,345	113	46,191
	2009	26	4,662	52	17,151	112	46,607
	2010	24	4,385	46	14,271	99	38,454
	2011	25	4,620	56	16,903	117	44,325
	2012	23	4,156	51	15,261	107	40,173
	2013	20	3,652	49	14,384	100	36,581
	2014	20	3,489	45	13,302	87	30,365
	2015	29	5,088	50	14,269	111	38,189
	2016	29	5,200	56	16,684	145	50,152
Dihydrocodeine	2007	0	106	0	72	2	598
	2008	0	90	0	72	1	624
	2009	0	63	0	37	1	254
	2010	0	51	0	45	1	463
	2011	0	57	0	31	1	583
	2012	0	47	0	41	1	437
	2013	0	33	0	20	1	212
	2014	0	3	0	5	0	30
	2015	0	3	0	4	0	42
	2016	0	11	0	30	0	138
Fentanyl LA	2007	7	39,517	68	186,756	126	712,603
	2008	7	39,802	65	199,327	139	831,872
	2009	7	39,279	46	147,537	132	784,515

		Commercial		Aged Medicare		Disabled Medicare	
DRUG		Fills per 1000 person-years	MME per 1000 person-years	Fills per 1000 person-years	MME per 1000 person-years	Fills per 1000 person-years	MME per 1000 person-years
	2010	7	37,786	42	130,966	145	790,173
	2011	6	35,307	42	134,001	163	883,420
	2012	6	33,327	40	127,787	167	914,448
	2013	6	30,964	40	127,379	175	935,264
	2014	5	28,281	41	125,495	172	912,060
	2015	5	26,208	38	115,745	161	826,646
	2016	5	24,875	36	112,684	145	714,974
Fentanyl SA	2007	1	5,940	0	897	7	58,634
	2008	0	4,657	0	2,264	6	70,574
	2009	0	4,220	0	778	3	40,889
	2010	0	3,425	0	412	3	32,714
	2011	0	2,886	0	305	2	30,417
	2012	0	1,988	0	419	2	21,281
	2013	0	2,430	0	578	2	27,433
	2014	0	3,436	0	1,721	4	41,595
	2015	0	3,746	0	1,858	4	56,543
	2016	0	1,429	0	1,225	2	24,461
Hydrocodone LA	2014	0	127	0	75	1	950
	2015	0	270	0	287	2	2,477
	2016	0	314	0	485	2	3,082
Hydrocodone SA	2007	247	80,584	493	209,611	1,559	1,003,006
	2008	261	88,259	527	245,451	1,674	1,142,250
	2009	265	92,749	534	252,639	1,832	1,238,006
	2010	265	95,576	554	256,194	1,867	1,243,232
	2011	273	99,275	605	281,234	1,991	1,335,538
	2012	265	98,347	550	264,761	1,862	1,274,250
	2013	245	93,855	535	263,222	1,774	1,229,637
	2014	216	87,477	467	235,327	1,570	1,112,443
	2015	164	72,932	377	200,215	1,317	956,284
	2016	155	69,814	412	235,767	1,437	1,064,551
Hydromorphone	2010	0	26	0	13	0	538
LA	2011	0	566	0	121	2	4,495
	2012	0	1,281	0	677	7	17,458
	2013	1	1,691	1	1,762	14	40,454
	2014	0	1,436	1	1,325	13	41,157
	2015	0	799	1	1,514	13	37,463
	2016	0	461	1	1,382	10	29,478
Hydromorphone	2007	4	4,454	6	5,583	46	117,181
SA	2008	4	5,228	7	7,091	54	145,460
	2009	5	6,306	7	8,808	68	145,185
	2010	5	6,566	7	8,069	69	134,774
	2011	5	7,093	10	10,780	89	176,335
	2012	6	7,724	11	13,686	105	230,219
	2013	5	7,336	11	14,400	111	239,966
	2014	5	6,815	11	14,909	108	228,068
	2015	5	6,191	11	13,439	114	232,407

DRUG		Commercial		Aged Medicare		Disabled Medicare	
		Fills per 1000 person-years	MME per 1000 person-years	Fills per 1000 person-years	MME per 1000 person-years	Fills per 1000 person-years	MME per 1000 person-years
	2016	4	5,833	11	14,766	101	204,032
Levorphanol	2007	0	83	0	404		
	2008	0	74	0	220	0	312
	2009	0	87	0	79	0	350
	2010	0	23		13	0	141
	2011	0	5		32		
	2012	0	74	0	19	0	98
	2013	0	22	0	56	0	364
	2014	0	31	0	194	0	1,354
	2015	0	36	0	112	1	2,354
	2016	0	78	0	92	0	941
Meperidine	2007	4	658	1	463	15	5,443
	2008	4	654	2	464	14	6,117
	2009	2	457	1	361	14	5,673
	2010	2	365	2	526	14	5,317
	2011	2	331	2	518	12	5,236
	2012	1	286	1	269	5	2,514
	2013	1	215	0	218	4	1,967
	2014	1	156	0	148	3	1,453
	2015	1	129	0	110	2	1,131
	2016	1	127	0	90	2	1,129
Methadone	2007	5	25,566	15	40,576	179	1,127,059
	2008	5	26,188	16	49,494	188	1,166,232
	2009	5	22,965	15	50,442	195	1,120,406
	2010	5	20,554	14	44,940	195	1,037,495
	2011	4	18,115	14	48,339	206	1,073,560
	2012	4	17,109	13	44,368	193	977,358
	2013	4	15,081	12	41,726	174	840,877
	2014	3	12,381	11	36,665	152	690,877
	2015	3	11,273	10	31,962	139	581,916
	2016	3	9,239	11	31,676	121	484,879
Morphine LA	2007	5	20,811	14	33,866	130	685,129
	2008	6	22,546	16	45,997	156	864,965
	2009	6	23,767	16	50,241	188	920,935
	2010	6	23,593	16	50,502	207	935,175
	2011	7	24,086	26	64,133	291	1,167,479
	2012	7	24,286	25	64,257	298	1,144,315
	2013	7	22,325	32	77,244	336	1,243,389
	2014	7	19,392	30	69,054	320	1,114,688
	2015	7	20,069	30	64,537	317	1,024,298
	2016	9	21,585	31	67,734	292	858,145
Morphine SA	2007	3	5,541	28	24,126	76	184,172
	2008	3	5,788	28	28,074	93	226,796
	2009	3	6,480	23	25,298	116	261,488
	2010	4	6,391	18	20,347	124	251,761

		Commercial		Aged Medicare		Disabled Medicare	
DRUG		Fills per 1000 person-years	MME per 1000 person-years	Fills per 1000 person-years	MME per 1000 person-years	Fills per 1000 person-years	MME per 1000 person-years
	2011	2	4,462	11	14,492	86	212,963
	2012	2	4,413	10	13,640	84	210,676
	2013	2	4,126	12	15,168	83	199,621
	2014	2	3,694	12	14,764	77	173,998
	2015	2	3,467	12	14,088	74	162,869
	2016	2	3,500	11	18,324	65	138,973
Opium	2007	0	171	0	122	1	420
	2008	0	137	0	136	0	306
	2009	0	155	0	102	0	268
	2010	0	202	0	79	0	351
	2011	0	215	0	144	1	1,031
	2012	0	178	0	140	0	759
	2013	0	133	0	138	1	960
	2014	0	143	0	156	1	988
	2015	0	143	0	188	1	873
	2016	0	126	0	180	1	653
Oxycodone LA	2007	13	63,806	42	92,115	228	1,229,679
	2008	14	65,767	44	109,036	265	1,609,900
	2009	14	70,534	36	99,981	286	1,658,645
	2010	14	69,152	34	95,712	284	1,539,340
	2011	12	52,764	33	91,431	260	1,383,379
	2012	11	47,066	31	88,640	257	1,350,406
	2013	10	40,156	17	45,461	119	628,584
	2014	9	33,711	16	41,724	117	564,549
	2015	6	23,432	16	42,509	122	553,224
	2016	4	14,858	14	39,986	97	410,419
Oxycodone SA	2007	80	61,398	157	111,647	667	1,069,792
	2008	86	73,379	181	152,801	851	1,601,017
	2009	90	83,482	171	156,450	931	1,770,162
	2010	94	98,227	176	173,212	1,023	2,076,656
	2011	96	103,431	205	218,837	1,235	2,722,149
	2012	95	99,620	210	237,311	1,305	2,880,710
	2013	90	92,672	220	247,600	1,314	2,763,716
	2014	87	85,831	211	235,189	1,294	2,603,569
	2015	91	89,636	215	241,232	1,364	2,662,560
	2016	90	93,317	222	265,613	1,320	2,531,111
Oxymorphone LA	2007	1	2,492	0	1,429	5	22,158
	2008	1	4,918	1	2,875	14	85,751
	2009	1	6,543	1	3,772	22	123,145
	2010	2	9,150	1	4,687	28	140,687
	2011	2	12,944	2	10,509	57	332,336
	2012	2	10,356	2	10,322	53	306,114
	2013	2	9,215	5	19,262	86	475,849
	2014	2	7,759	5	18,182	78	418,686
	2015	2	7,939	4	14,828	66	335,821
	2016	2	8,019	4	15,205	59	271,863

		Commercial		Aged Medicare		Disabled Medicare	
DRUG		Fills per 1000 person-years	MME per 1000 person-years	Fills per 1000 person-years	MME per 1000 person-years	Fills per 1000 person-years	MME per 1000 person-years
Oxymorphone SA	2007	0	499	0	77	2	5,199
	2008	0	752	0	280	5	13,116
	2009	0	1,237	0	474	7	19,120
	2010	0	1,424	0	352	6	16,058
	2011	1	1,653	0	821	12	31,181
	2012	0	1,235	0	792	9	24,205
	2013	0	1,309	1	1,539	14	38,760
	2014	0	1,311	1	1,694	16	43,687
	2015	0	1,359	1	1,648	14	36,673
	2016	1	1,375	1	1,495	8	21,818
Pentazocine	2007	1	775	1	2,446	10	11,963
	2008	1	622	1	2,288	8	10,513
	2009	0	508	1	1,279	6	9,416
	2010	0	484	1	1,089	5	7,848
	2011	1	653	1	1,421	6	10,874
	2012	1	550	1	802	2	4,507
	2013	0	460	0	661	2	3,637
	2014	0	336	0	375	1	2,733
	2015	0	340	0	245	1	1,997
	2016	0	278	0	159	1	2,326
Propoxyphene	2007	42	28,305	81	82,417	138	145,304
	2008	42	28,227	79	87,972	140	170,497
	2009	37	25,884	79	85,099	155	180,274
	2010	32	22,627	126	122,415	201	214,300
	2011	0	3	0	27		32
Tapentadol LA	2011	0	43	0	17	0	362
	2012	0	1,427	0	1,060	4	13,459
	2013	1	2,483	1	2,519	10	31,675
	2014	1	2,298	1	2,859	10	33,178
	2015	1	2,575	1	3,010	13	41,789
	2016	1	2,983	2	4,584	19	57,518
Tapentadol SA	2009	0	667	0	219	2	3,520
	2010	1	3,189	0	660	4	9,303
	2011	3	5,381	1	1,414	6	16,771
	2012	2	5,489	1	1,847	8	23,232
	2013	2	4,563	1	1,737	8	23,607
	2014	1	3,747	1	1,827	8	24,526
	2015	1	3,522	1	2,223	9	26,866
	2016	1	3,584	1	2,310	8	23,442
Tramadol LA	2007	3	1,561	5	2,590	15	10,116
	2008	3	1,917	6	3,958	20	16,279
	2009	3	1,771	4	2,976	17	13,184
	2010	2	1,488	3	1,543	8	5,707
	2011	2	1,282	3	1,747	11	6,924
	2012	2	1,193	3	1,581	11	7,760
	2013	2	1,158	3	1,721	13	9,032

		Commercial		Aged Medicare		Disabled Medicare	
DRUG		Fills per 1000 person-years	MME per 1000 person-years	Fills per 1000 person-years	MME per 1000 person-years	Fills per 1000 person-years	MME per 1000 person-years
	2014	2	1,090	3	1,978	11	8,977
	2015	2	1,027	3	1,946	11	7,186
	2016	2	975	3	1,966	11	6,994
Tramadol SA	2007	43	14,429	167	64,784	305	147,065
	2008	47	16,426	182	77,634	343	172,763
	2009	49	18,562	178	77,785	389	198,143
	2010	51	19,884	189	80,028	413	208,391
	2011	63	23,523	250	103,644	508	254,211
	2012	67	25,036	251	105,696	521	260,345
	2013	69	25,817	269	113,696	546	272,425
	2014	68	25,381	266	109,957	539	260,854
	2015	69	24,518	257	103,494	500	235,815
	2016	69	26,230	288	115,705	571	261,512

Appendix 10: Time trends in concentration of opioid use by use percentiles

Figure A7: Trends in opioid use concentration: Commercial population. Lines represent a percentile of opioid use; for example, the darkest/lowest line p0.01 represents the top 1 percent of all opioid users. To interpret: in 2007, the top 1 percent of opioid users accounted for 45% of all opioids used by volume (MME). The top 5 percent used 74% of all opioids, etc.

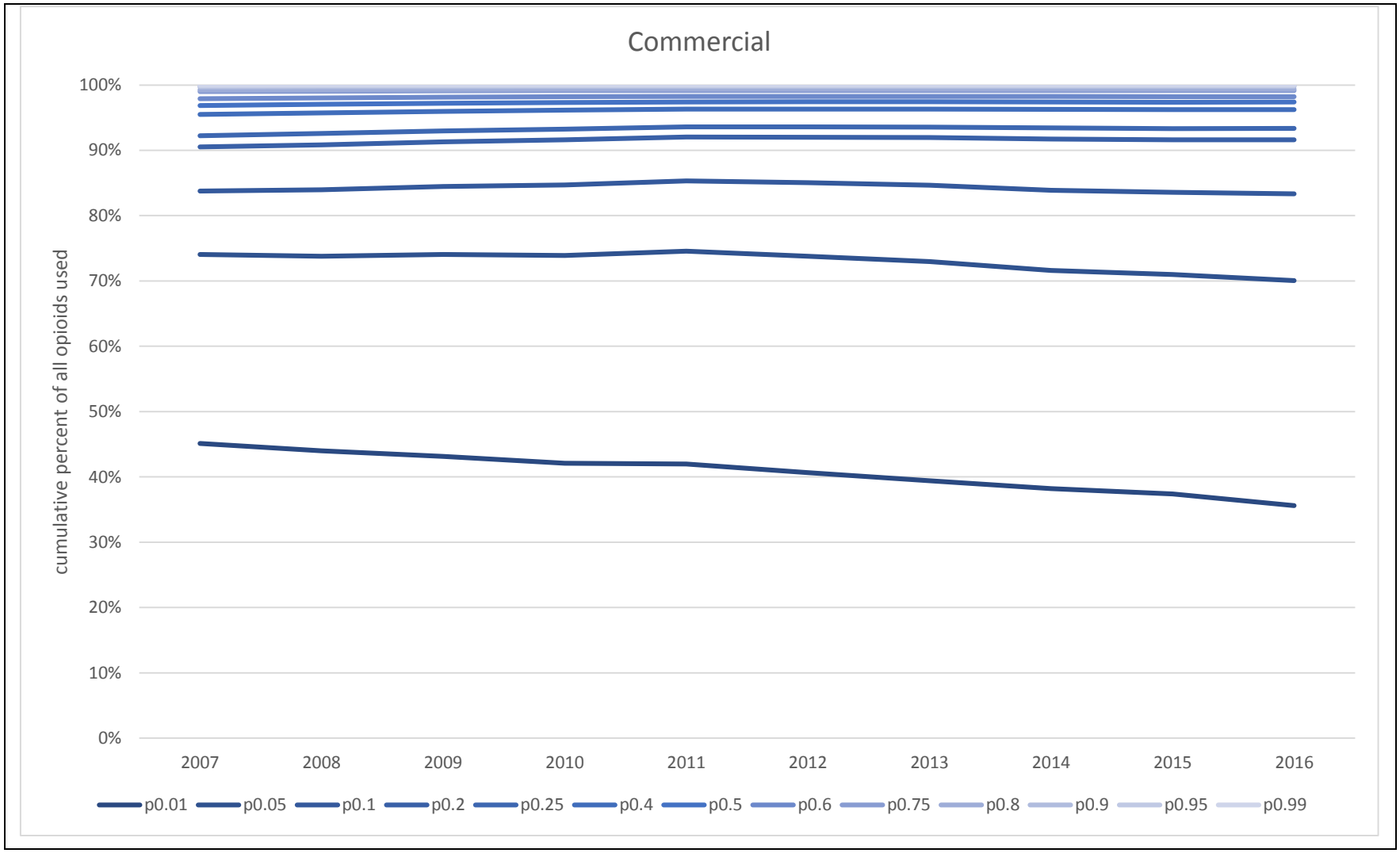


Figure A8 Trends in opioid use concentration: Aged Medicare population. Lines represent a percentile of opioid use; for example, the darkest/lowest line p0.01 represents the top 1 percent of all opioid users. To interpret: in 2007, the top 1 percent of opioid users accounted for 25% of all opioids used by volume (MME). The top 5 percent used 53% of all opioids, etc.

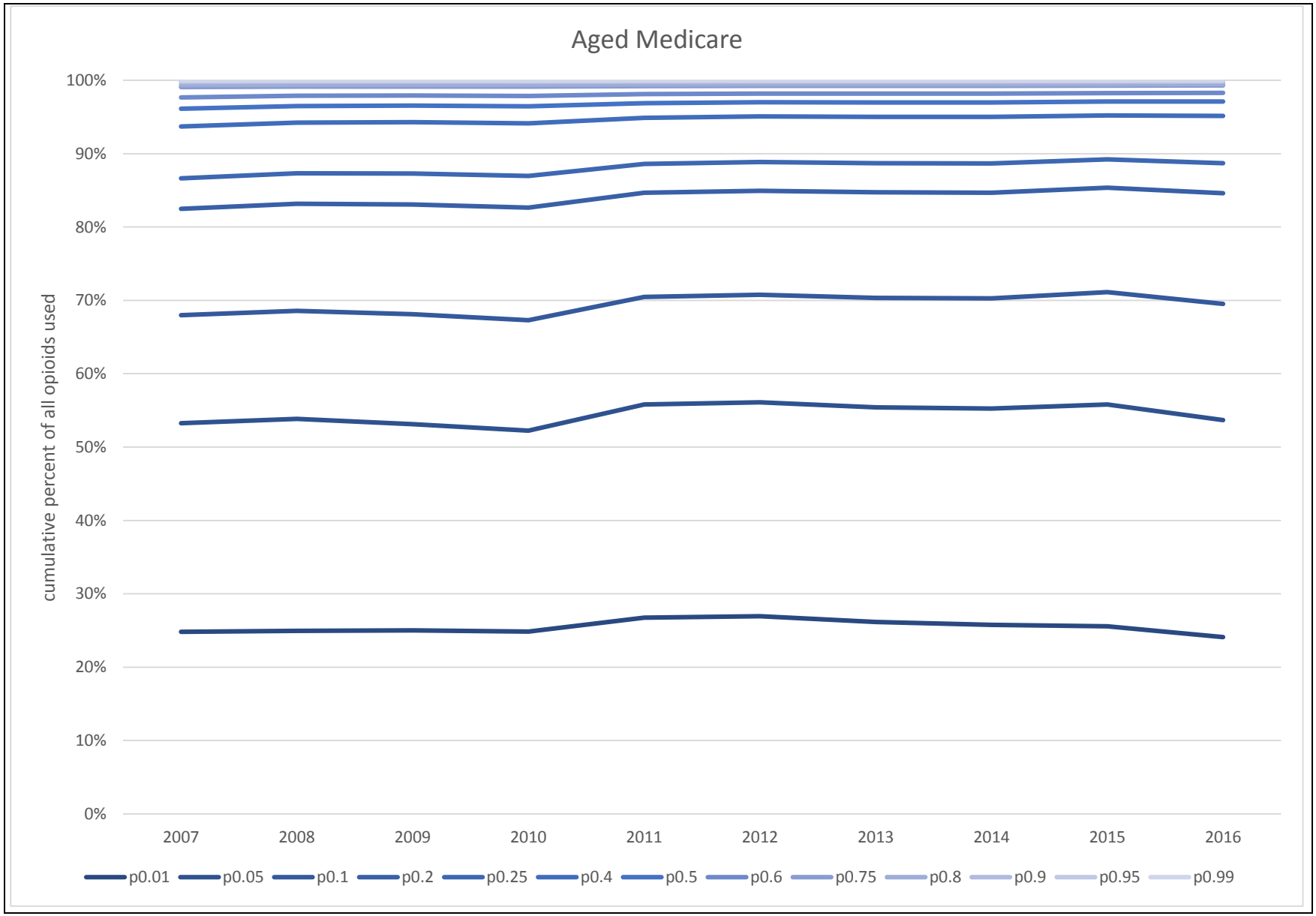
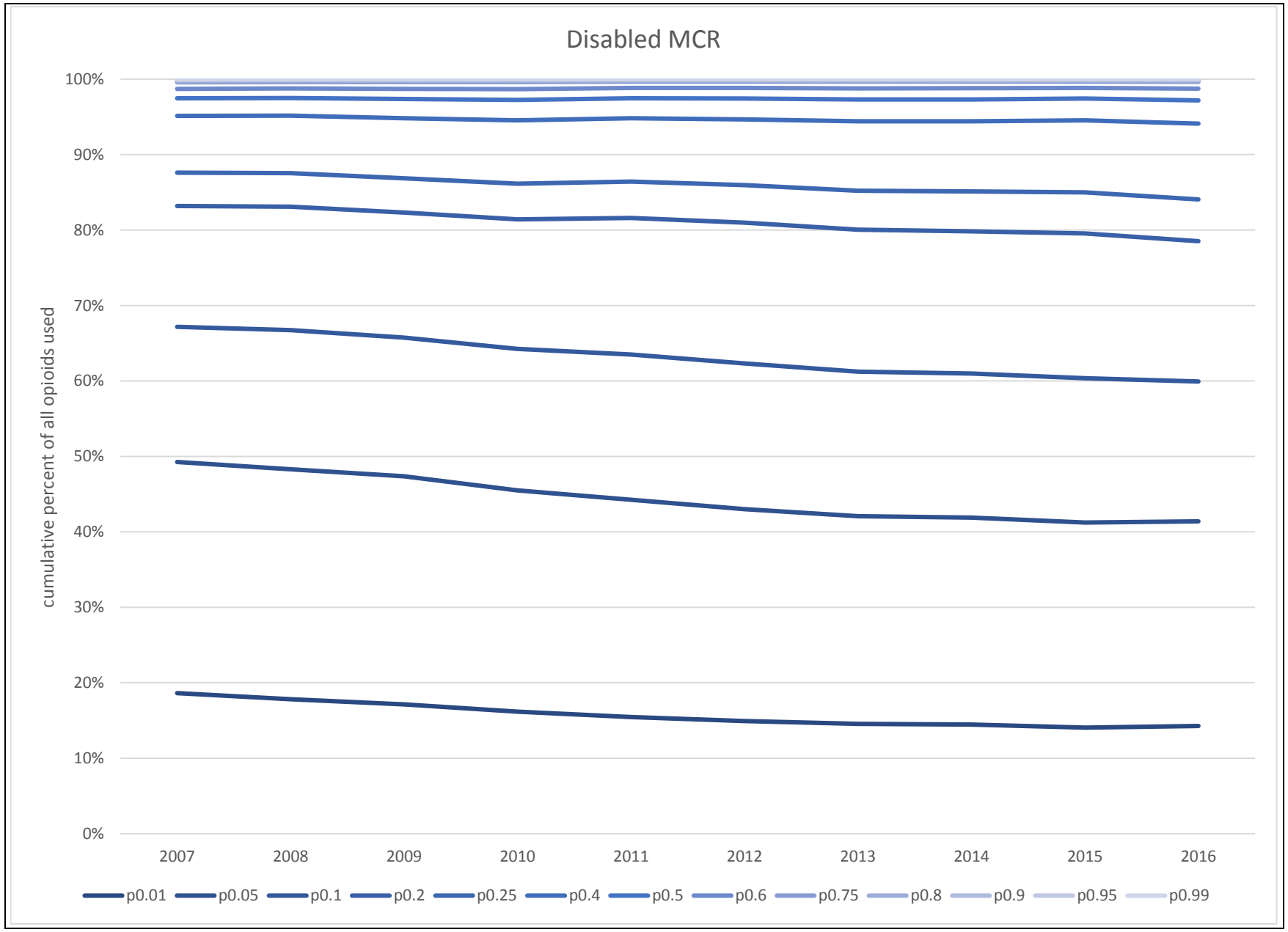


Figure A9 Trends in opioid use concentration: Disabled Medicare population. Lines represent a percentile of opioid use; for example, the darkest/lowest line p0.01 represents the top 1 percent of all opioid users. To interpret: in 2007, the top 1 percent of opioid users accounted for 19% of all opioids used by volume (MME). The top 5 percent used 49% of all opioids, etc.



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