

Spatio-temporal effects in drug sales, in association with demographics, provider, drugs choices and disease

Team MEROPS (bee-eaters)
Monash Experts in R, Organising Pharmaceutical Sales

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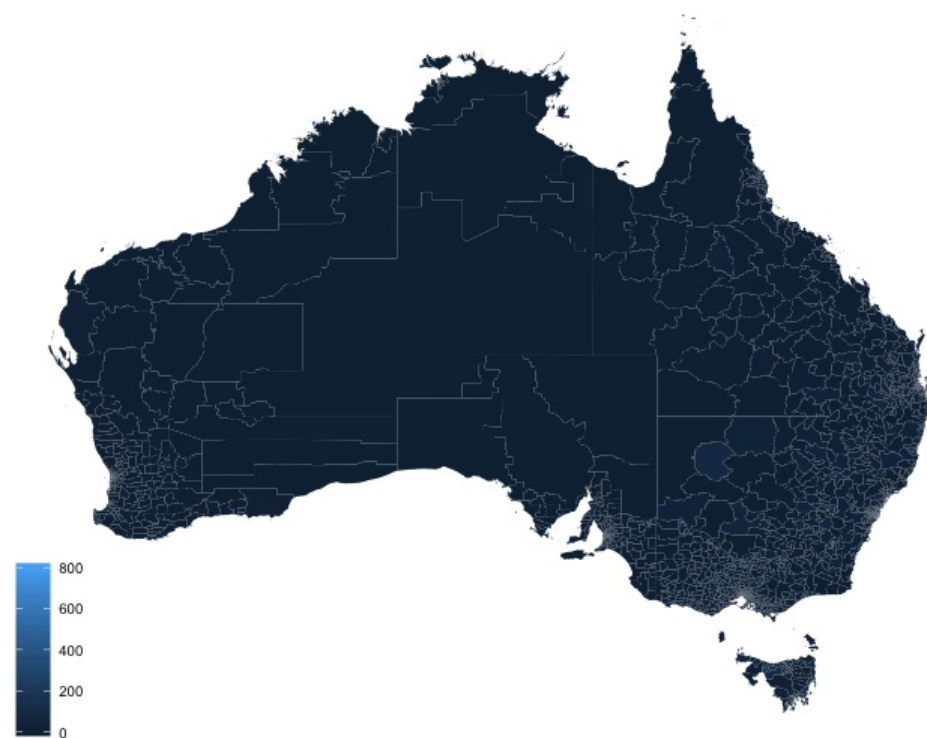


Outline

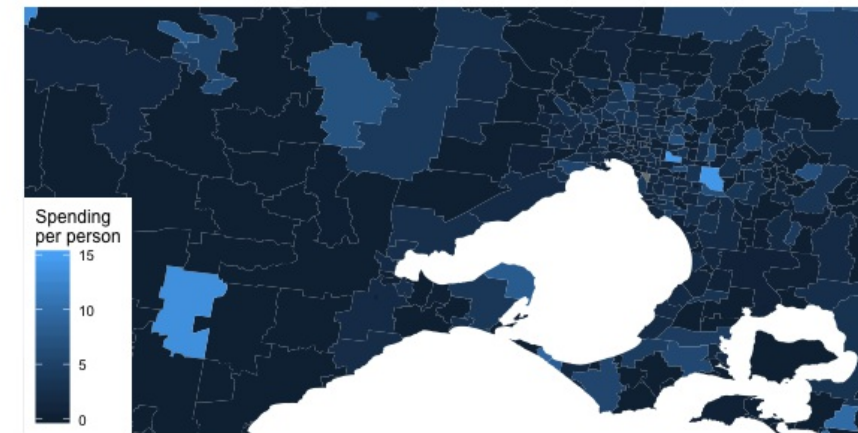
- Spatial distribution
- Temporal trends in drug sales
- Effect of the PBS safety net
- Demographics
- Do providers have brand preferences?
- Fantastic beasts and where to find them ...

Spending per person by postcode

Across all of Australia,

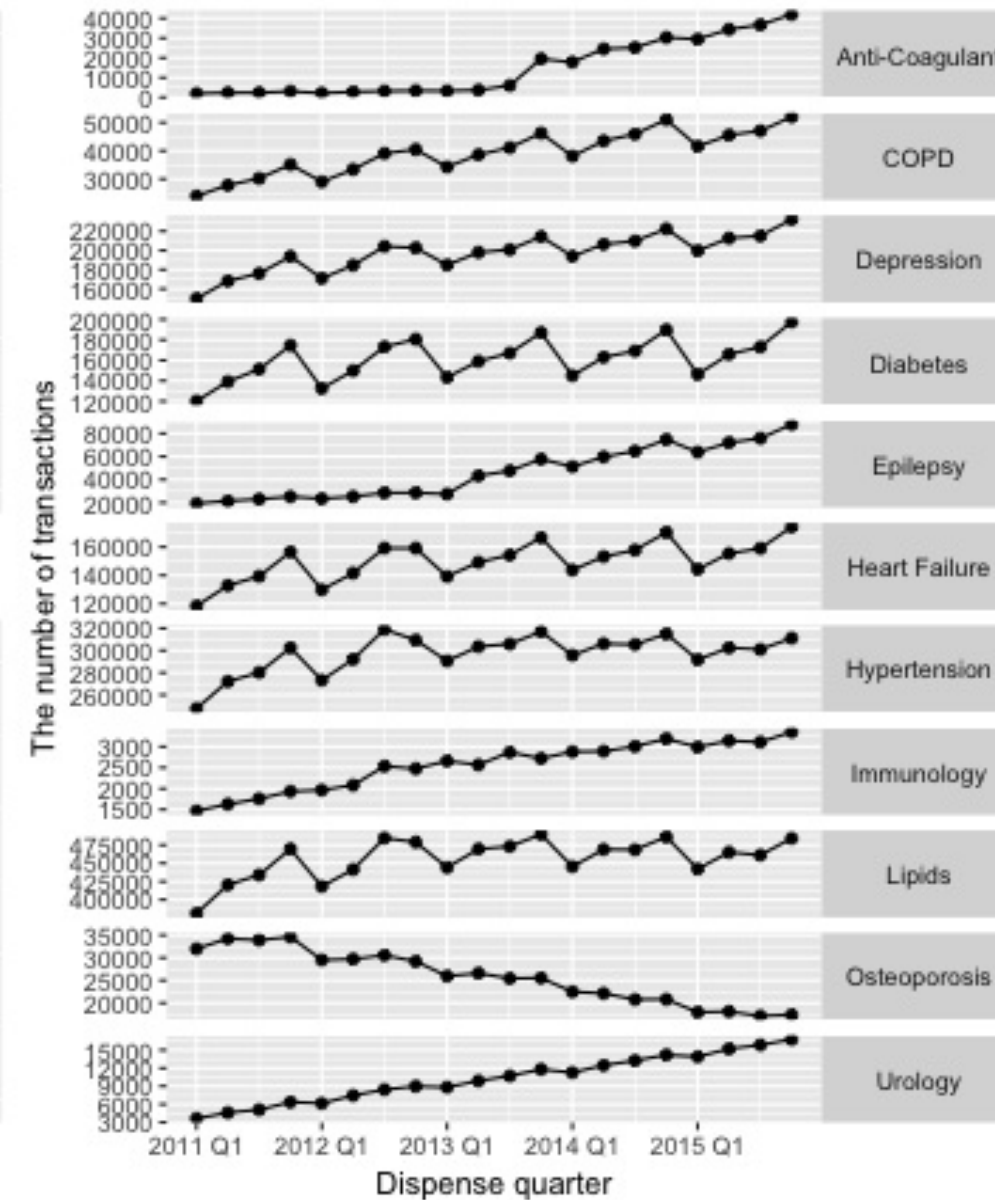
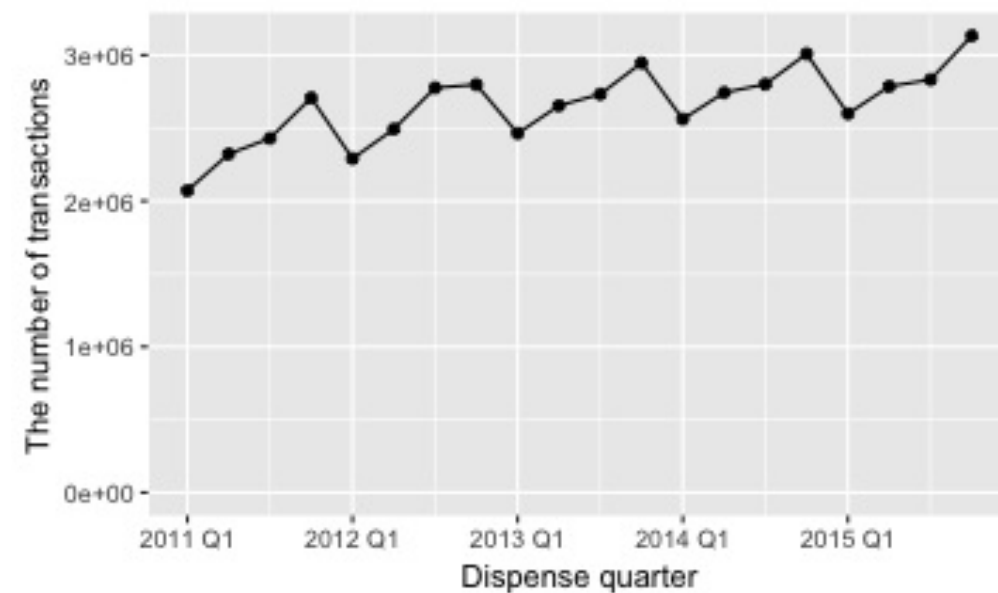
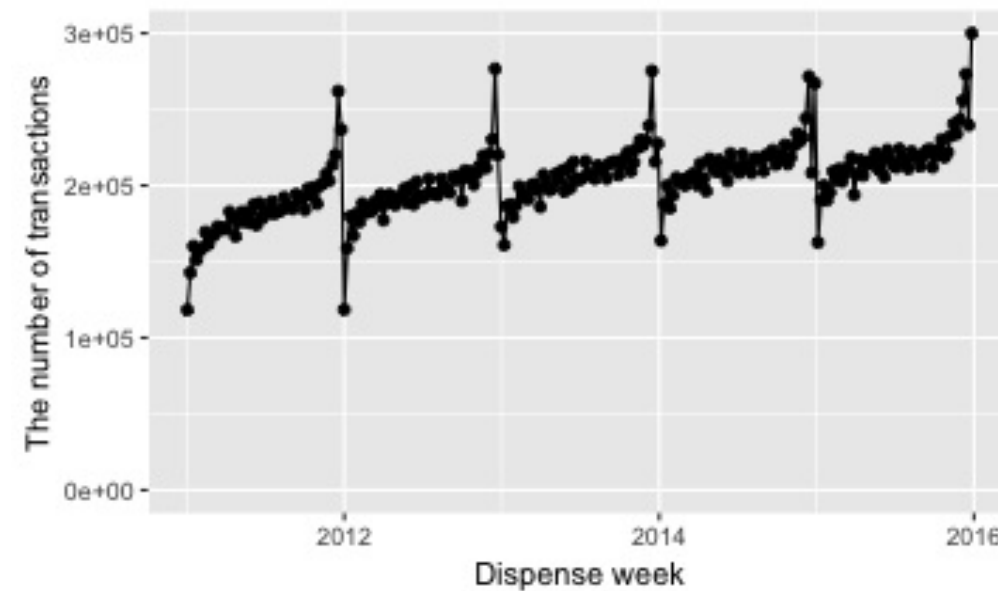


and focusing on Melbourne



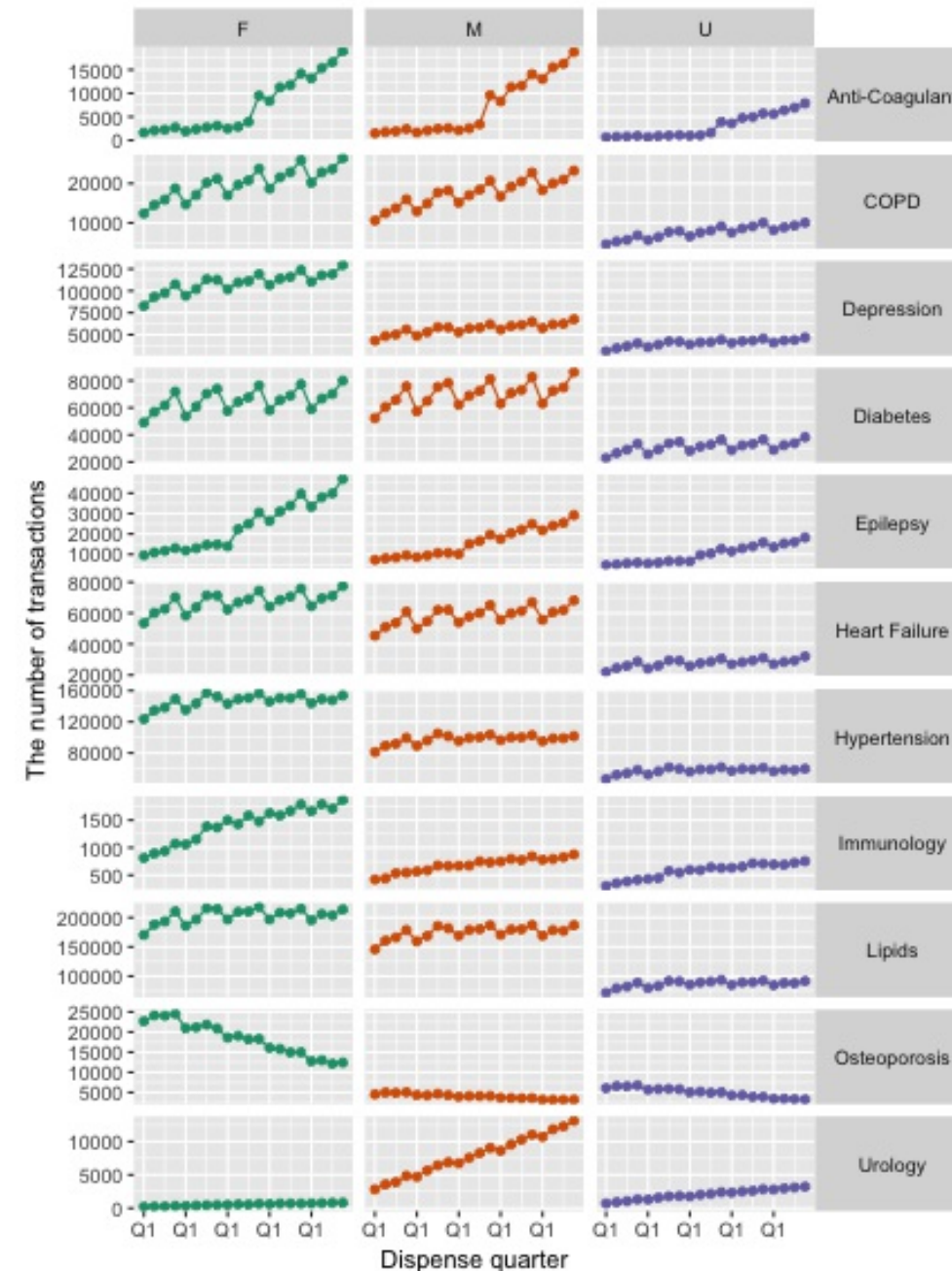
Using total population of postcode. Per person spending would be higher than these numbers given that only one supplier is represented.

Drug sales increasing over time, with seasonality, except for osteoporosis

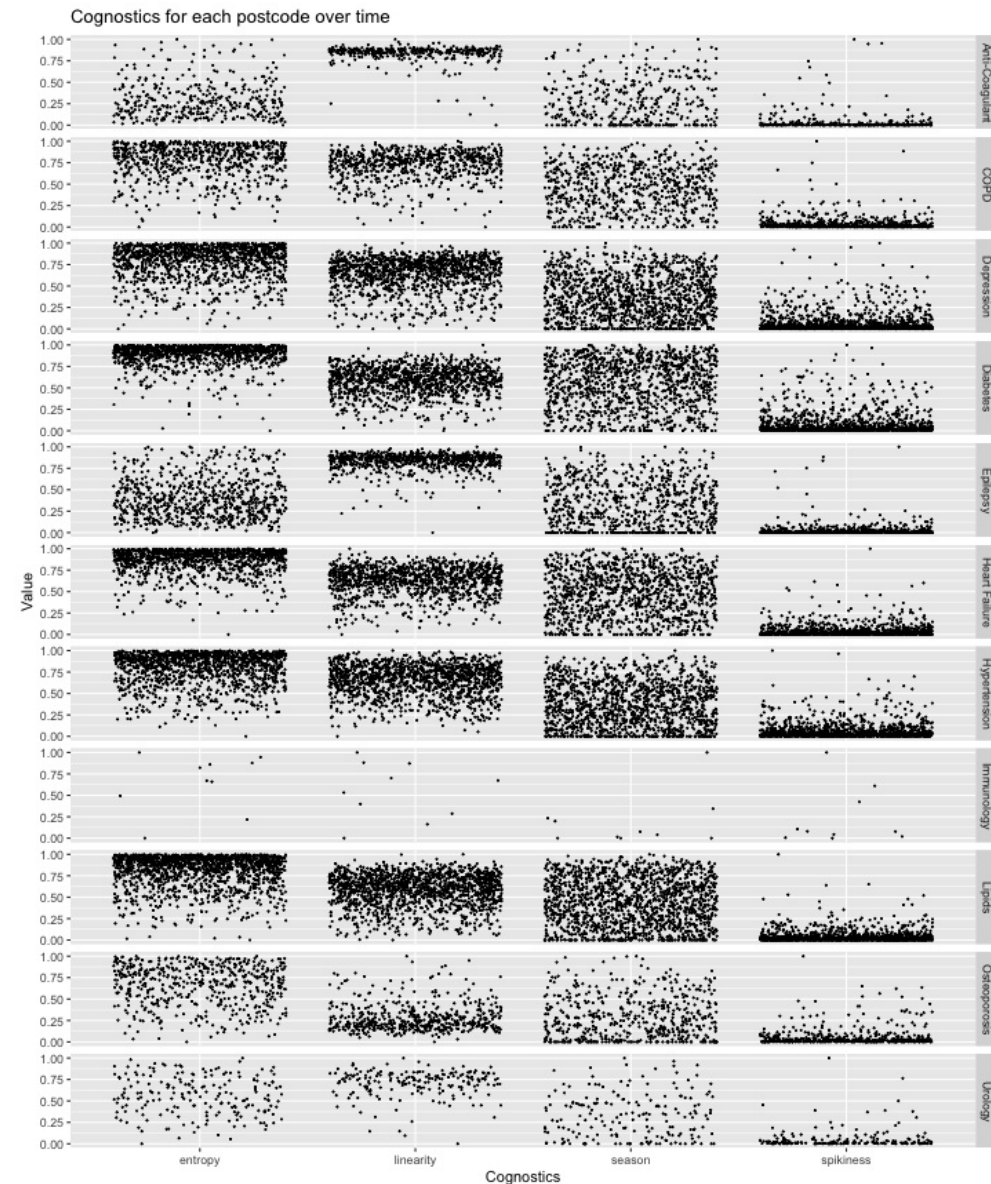


By gender

- Decrease in osteoporosis drugs primarily due to women, and
- increase in urology drugs primarily due to men.
- Women are the primary recipients of drugs for depression, hypertension, and
- contribute more to increase in immunology drugs.



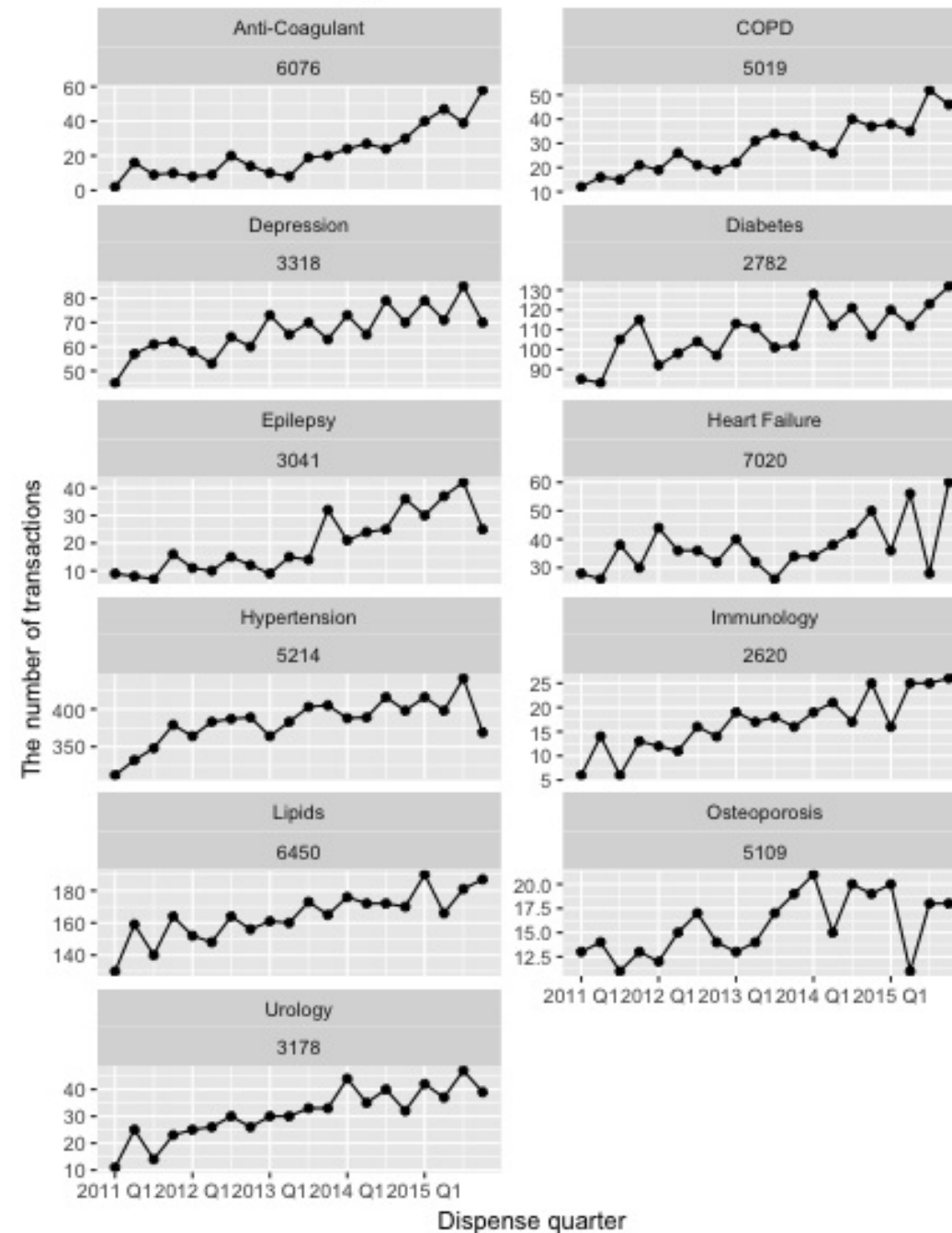
Digging out some postcodes of interest?



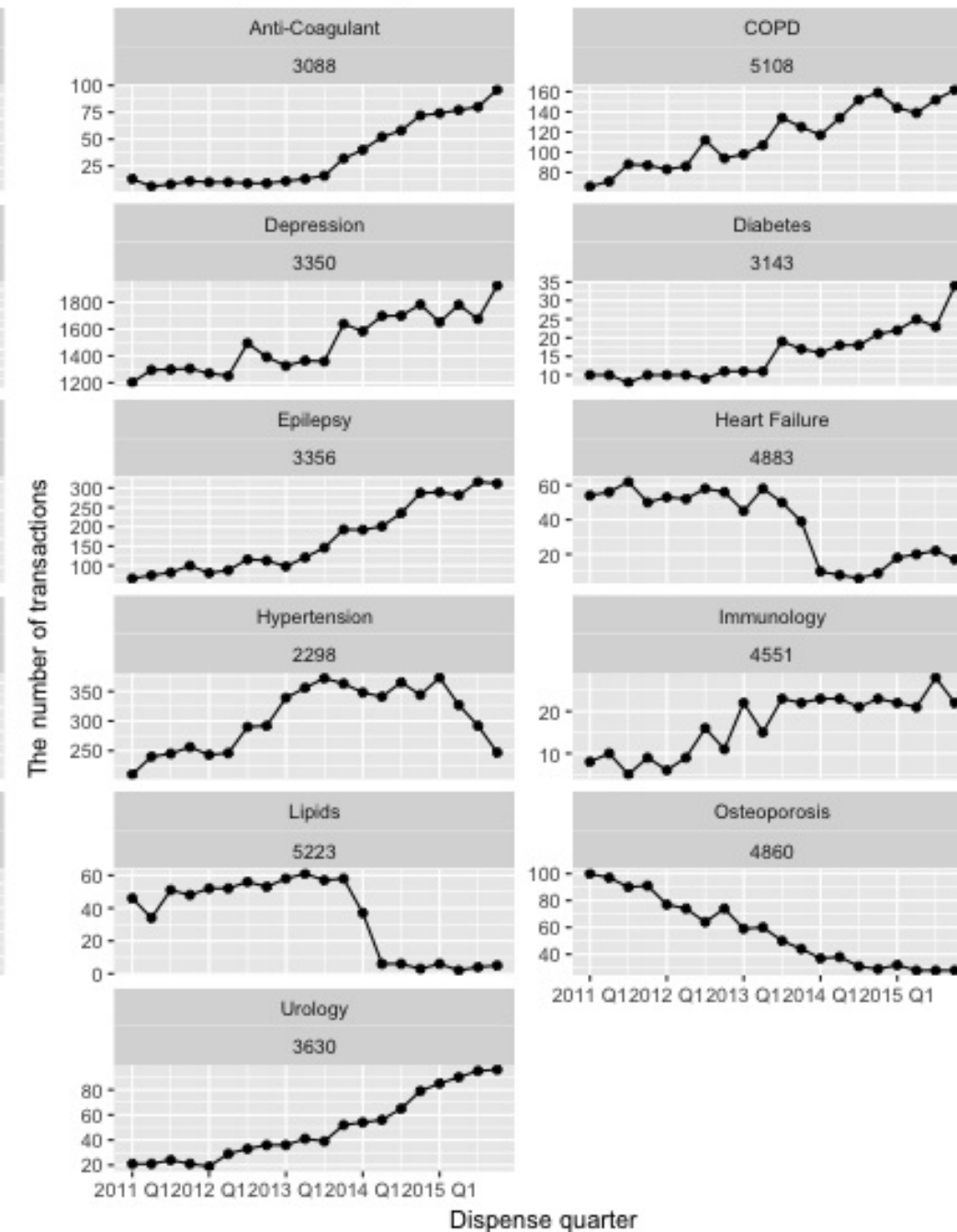
- Time series cognostics measure various aspects such as overall variability (entropy), linear trend, seasonality and spikiness.
- These are computed for each postcode, giving them a rating on these sorts of patterns.
- The jittered dot plot on the left shows the ratings on different measures for each postcode, faceted by the diseases. Each dot represents a postcode.

Digging out some postcodes of interest?

The most increasing postcode over time

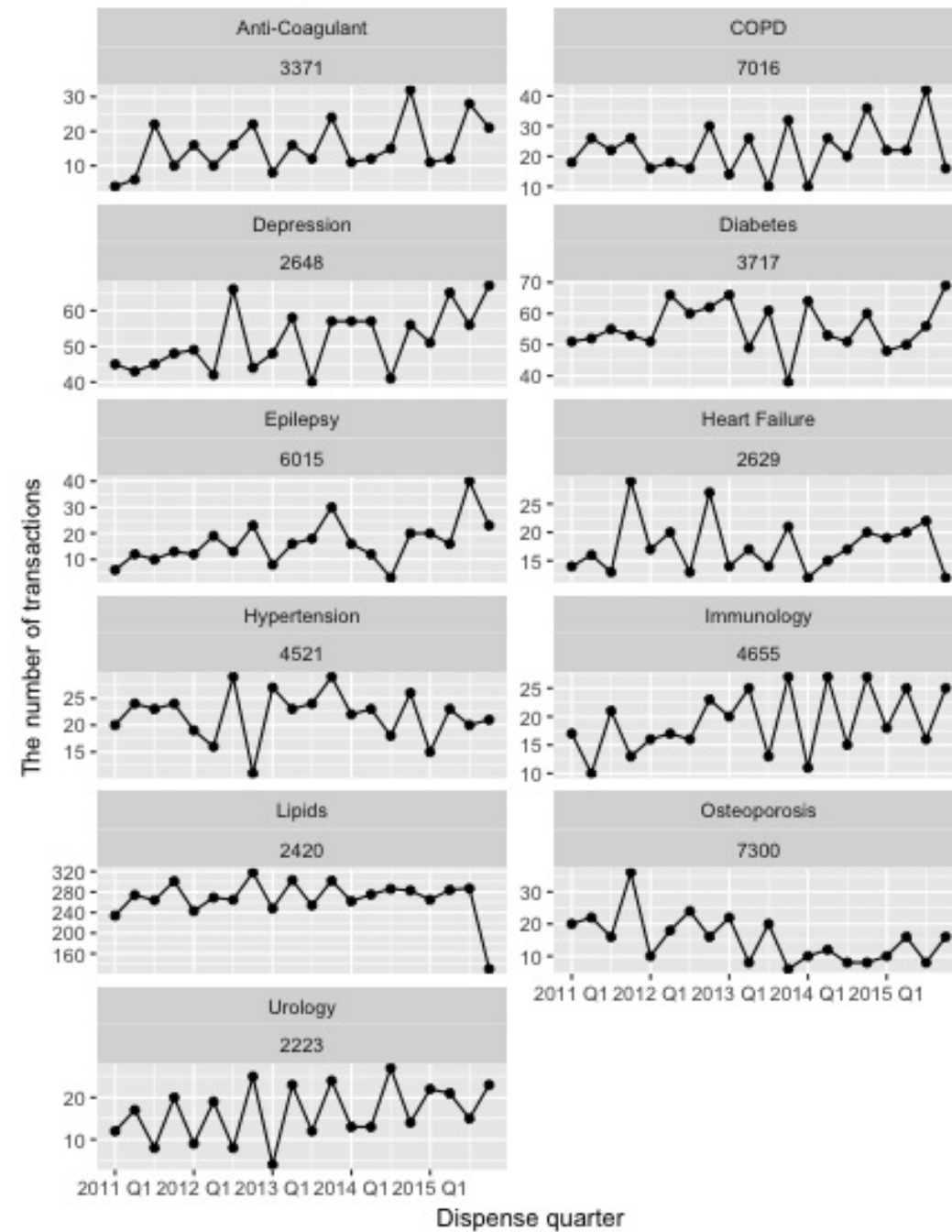


The most predictable postcode over time

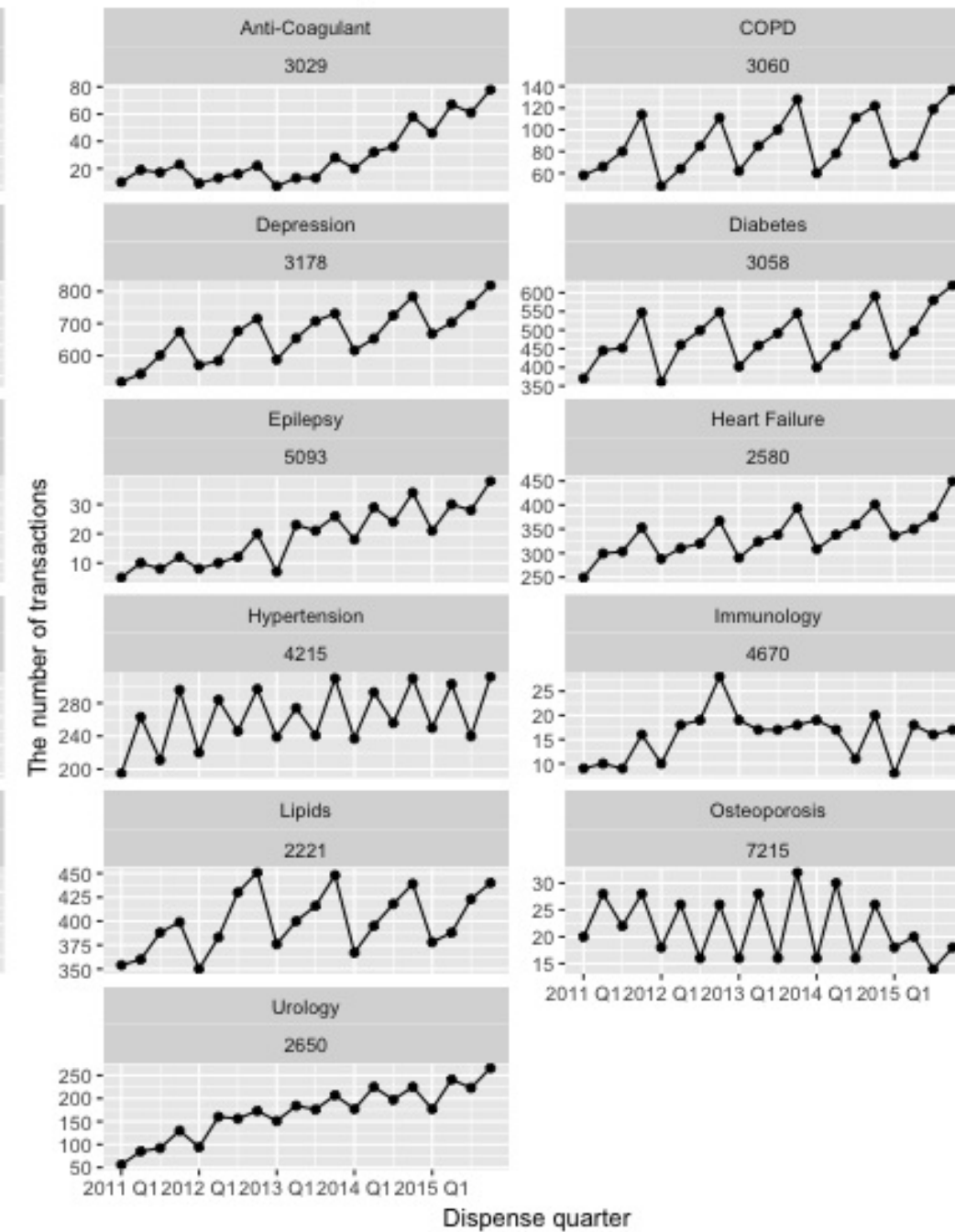


Digging out some postcodes of interest?

The most spiky postcode over time



The most seasonal postcode over time



The PBS safety net

Concession cards available to the elderly, disabled, unemployed, etc. Currently [1]:

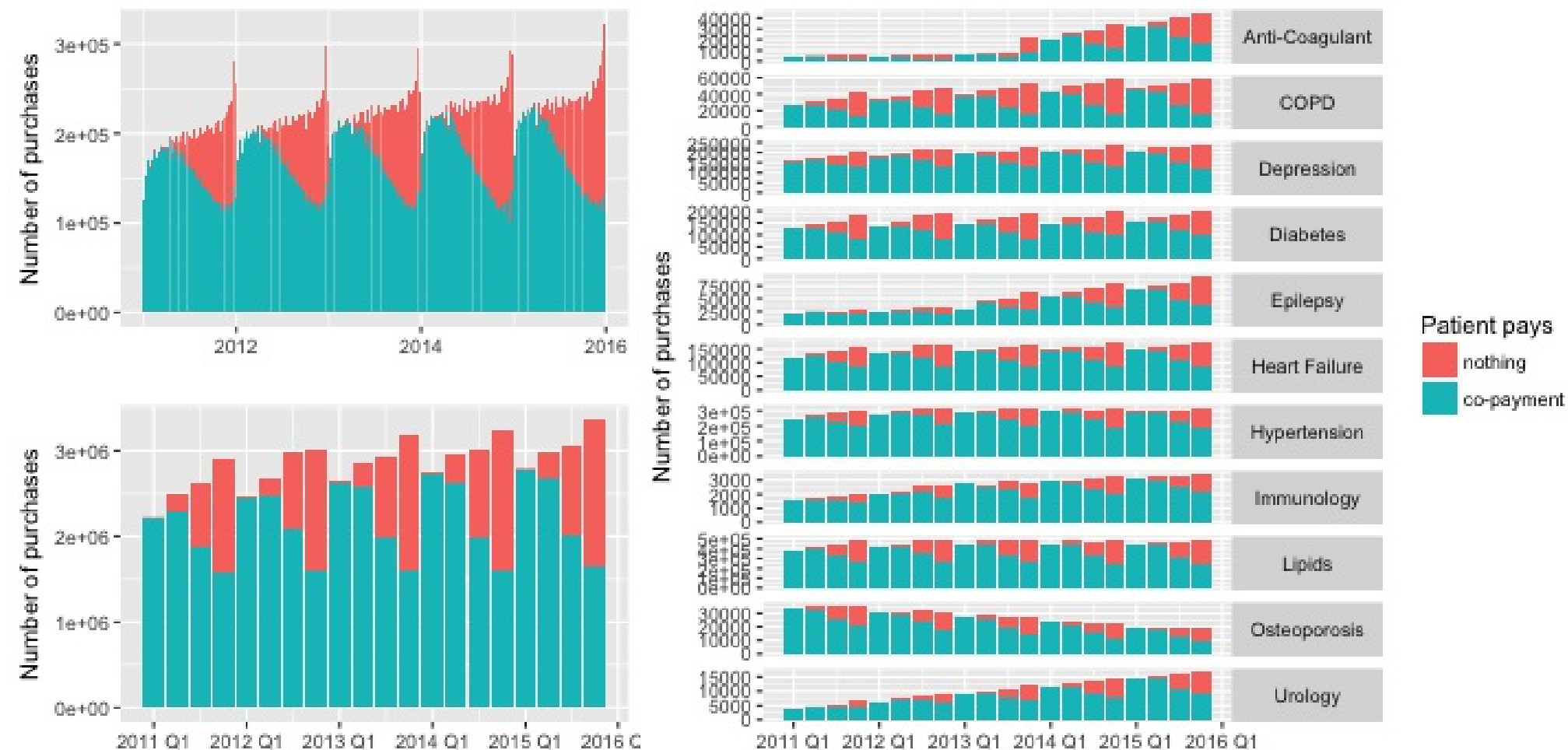
- Concession card holders pay \$6.30 per purchase but **nothing** beyond \$378.00 each year.
- Non-concession card holders \$38.80 per purchase but \$6.30 beyond \$1,494.90 each year.

In 2015-2016 [2], **59.3%** of PBS spending was for concession card holders, 16.6% to non-concession card holders, 23.8% on "Section 100" drugs -- specialized drugs outside of normal PBS arrangements, and 0.3% on other categories.

19.4% of PBS spending was on the safety net for concession card holders, where the government pays the entire amount. This can be seen in the data.

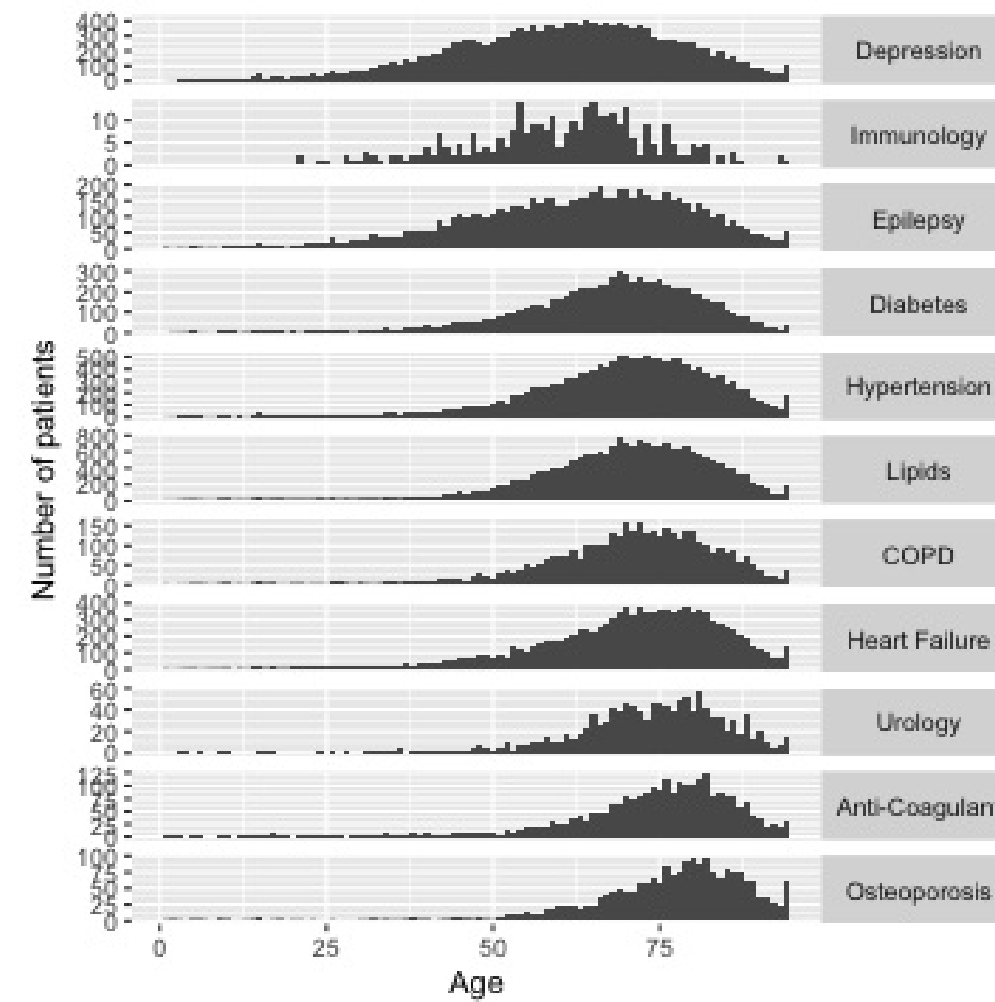
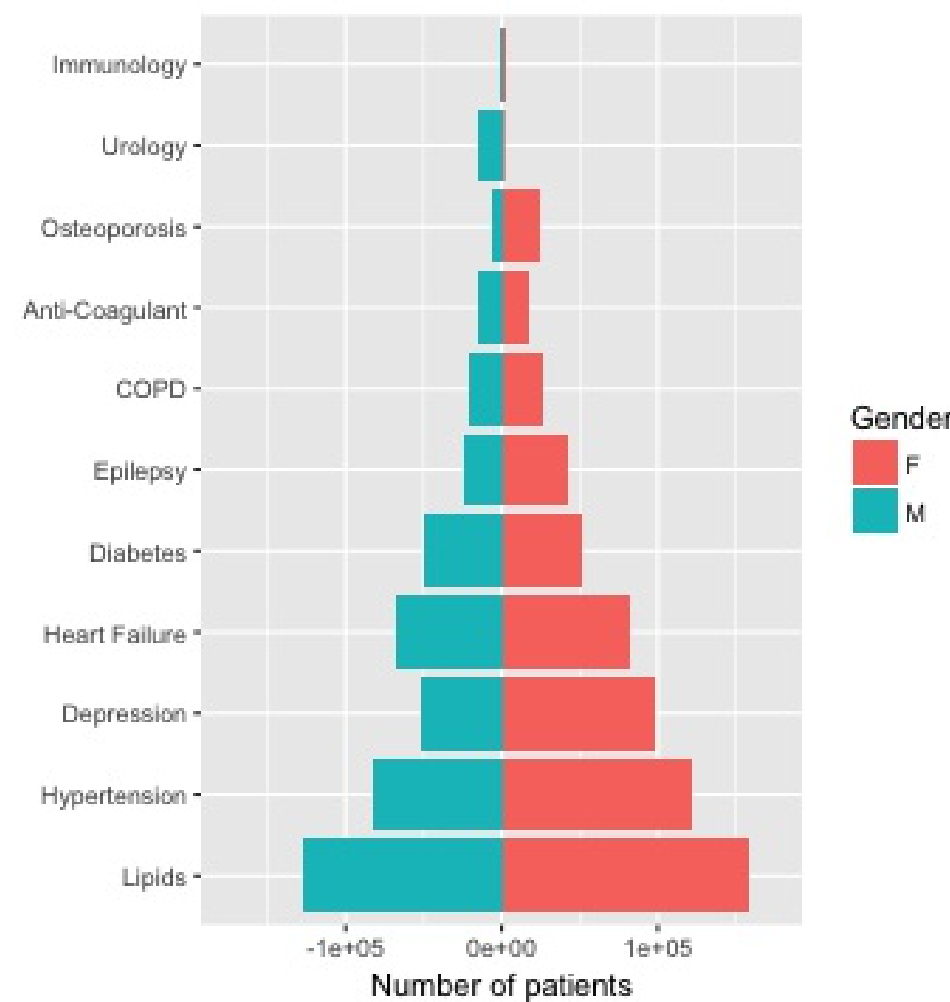
1. <https://www.humanservices.gov.au/customer/services/medicare/pharmaceutical-benefits-scheme-pbs-safety-net>
2. <http://www.pbs.gov.au/statistics/expenditure-prescriptions/2015-2016/expenditure-prescriptions-report-2015-16.pdf>

Patients obtain less drugs before hitting the PBS safety net each year, including for chronic illnesses



Demographics of chronic illness

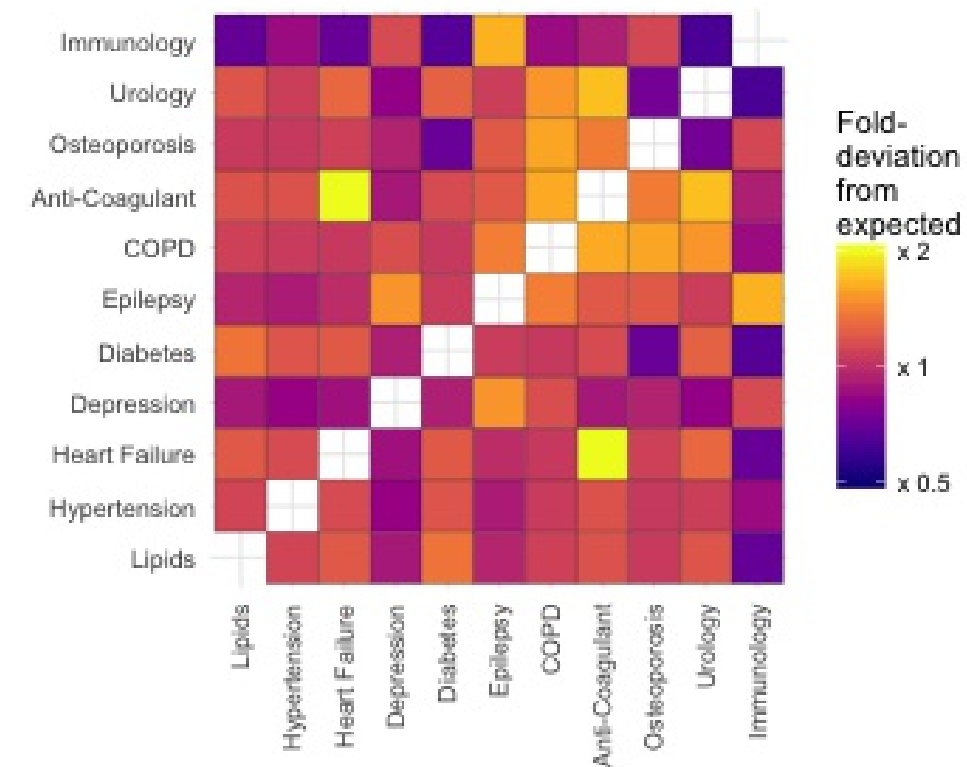
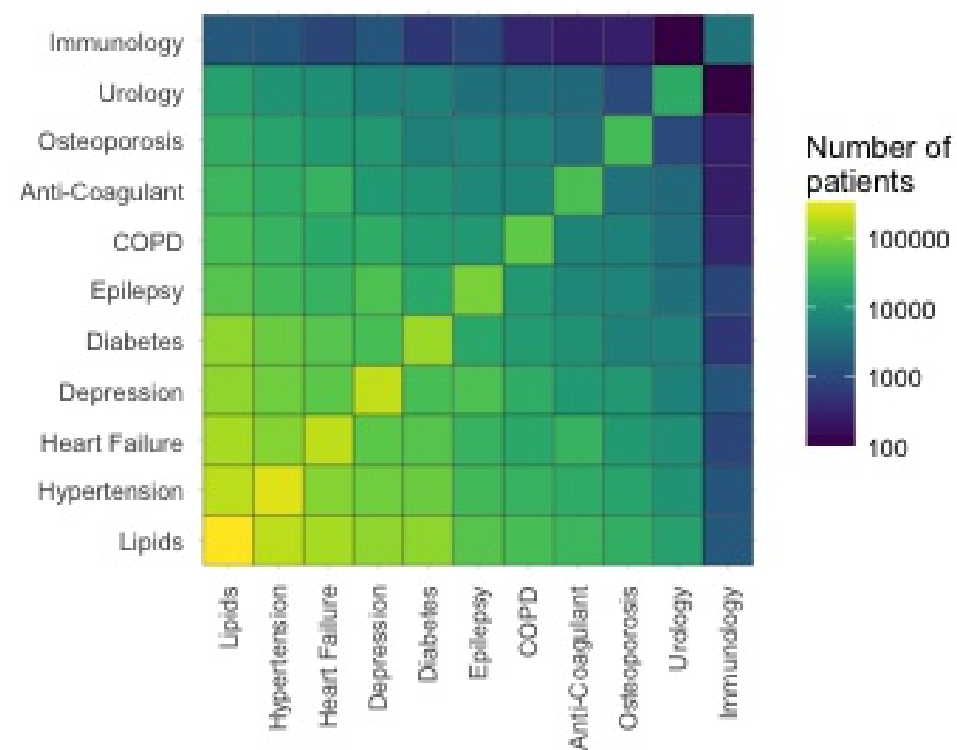
558,352 patients. Have gender of 79% of patients (42% male, 58% female), and the year of birth of 6.7%.



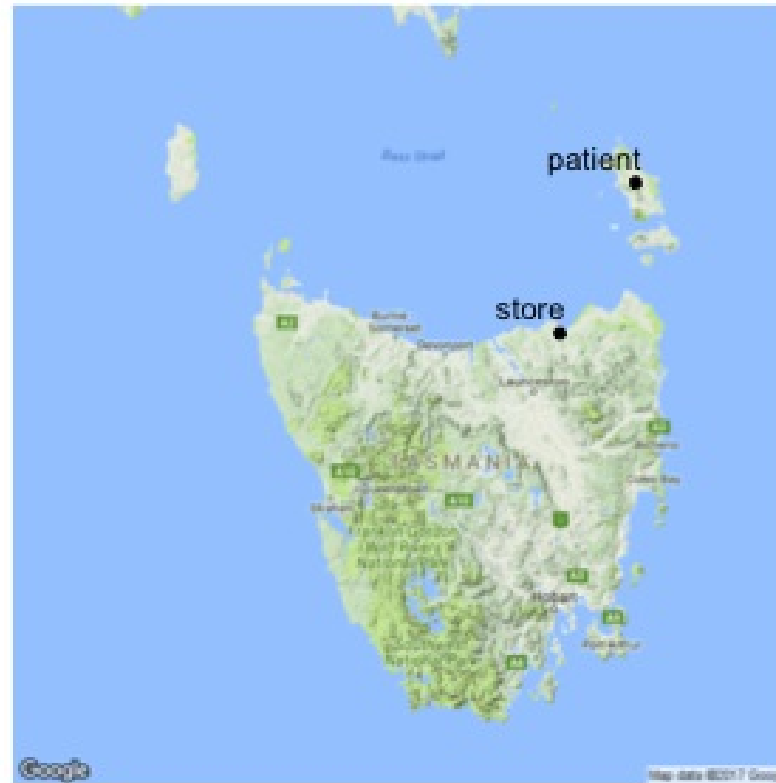
Co-morbidity of chronic illness

Possible causes of clustering:

- Diseases of old age
- Metabolic syndrome: obesity, high cholesterol ("lipids"), hypertension and heart failure, diabetes



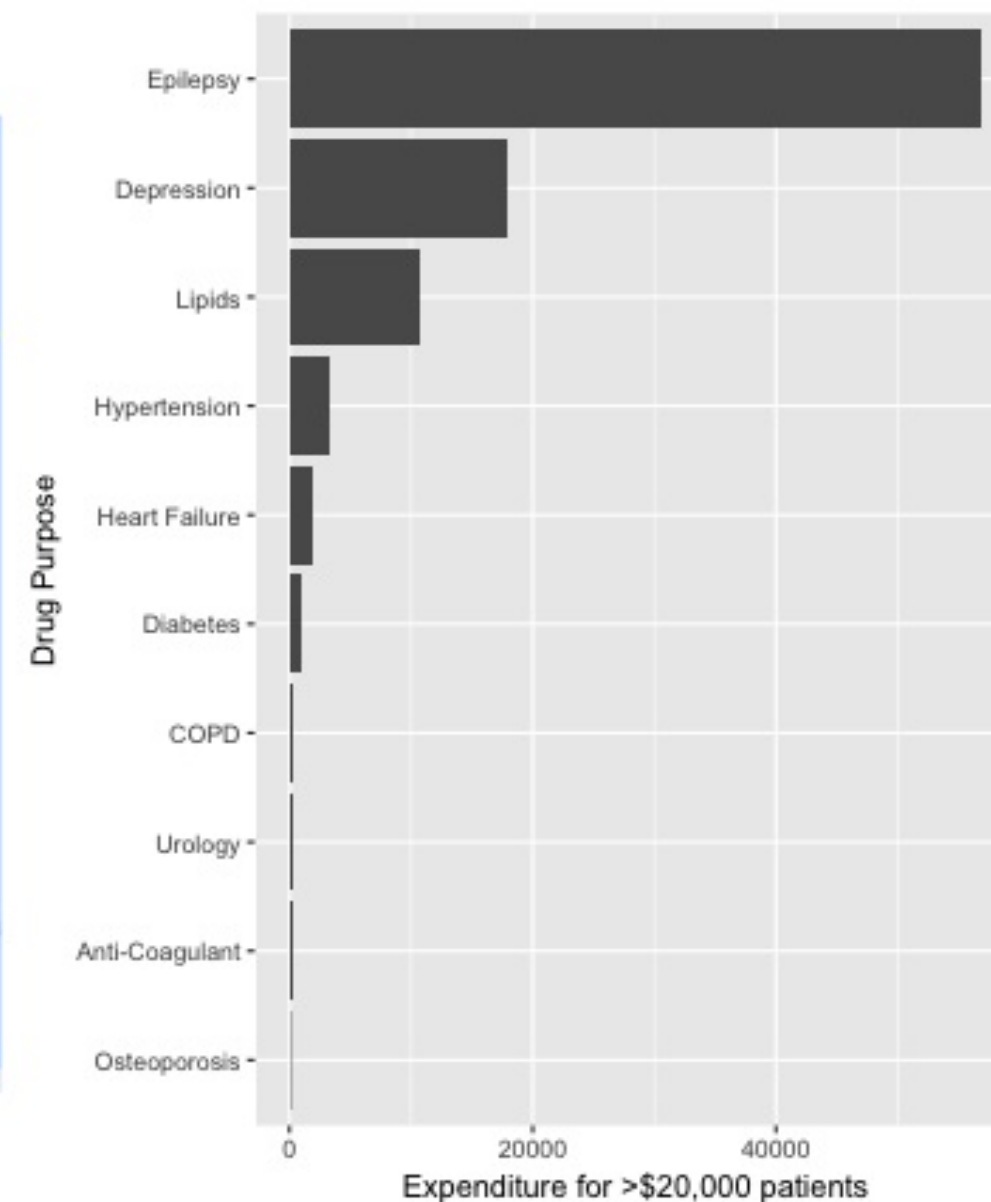
One patient who spent \$25000 lives on



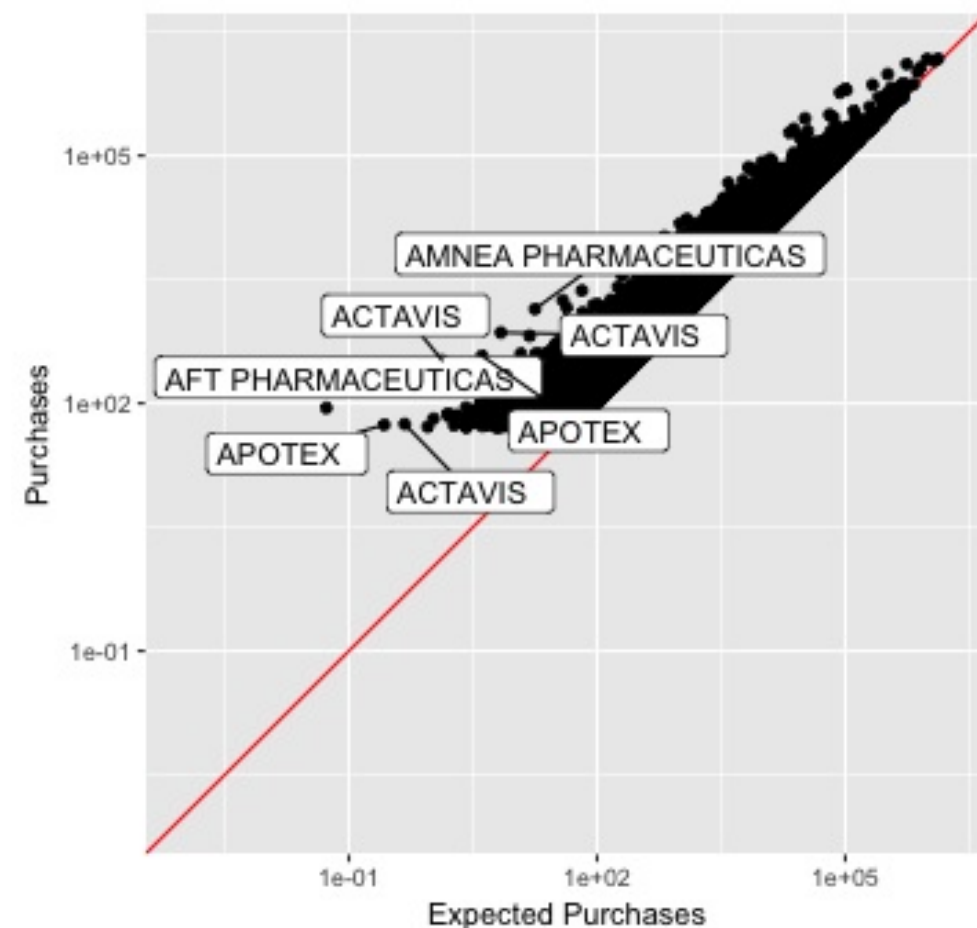
Flinders Island and buys their drugs on mainland Tasmania. Treatment was for Epilepsy and Depression.

Hey, Big Spender!

24 patients around Australia spent more than \$20,000 on prescriptions. The top spending was on drugs for epilepsy, and depression.



Preferential prescriptions



Drug prescription purchases for postcode by expected market share. There is some evidence of prescribers making drug preferences for their patients.

- Many manufacturers compete to sell the same generic ingredient.
- Doctors in a postcode may have a favoured manufacturer, and prescribe that company's drugs more than expected.
- Apotex Pty Ltd drugs are sometimes prescribed >100 times as often as their market share dictates.

Apotex and Pravastatin

- Pravastatin is a common anti-cholesterol drug, with over 2,000,000 purchases.
- 14 Manufacturers compete at 4 different dosages.
- Two of Apotex's products make up less than half a percent of the 20-40mg Market.
- A prescriber in postcode 6216 (Woodanilling) prescribed the drug Pravastatin 78 times, 55 of which were from Apotex, about about 140 times the typical prescription rate.
- From wikipedia: Woodanilling is a small town in the Great Southern region of Western Australia, 254 kilometres south of Perth on the Great Southern Highway, 24 kilometres from Katanning and 30 kilometres from Wagin.

Acknowledgements

All analysis was done using **R**, using the packages **knitr**, **zoo**, **RSQLite**, **forcats**, **tidyverse**, **lubridate**, **gridExtra**, **ggthemes**, **viridis**, **ggrepel** and their dependencies.

Slides created via the R package **xaringan**.

The chakra comes from **remark.js**, **knitr**, and **R Markdown**.

Rainbow bee-eater (*merops ornatus*) photo by JJ Harrison, CC license

Thanks to Phil Brierley for organising the datathon, and NostraData for making the data available.