

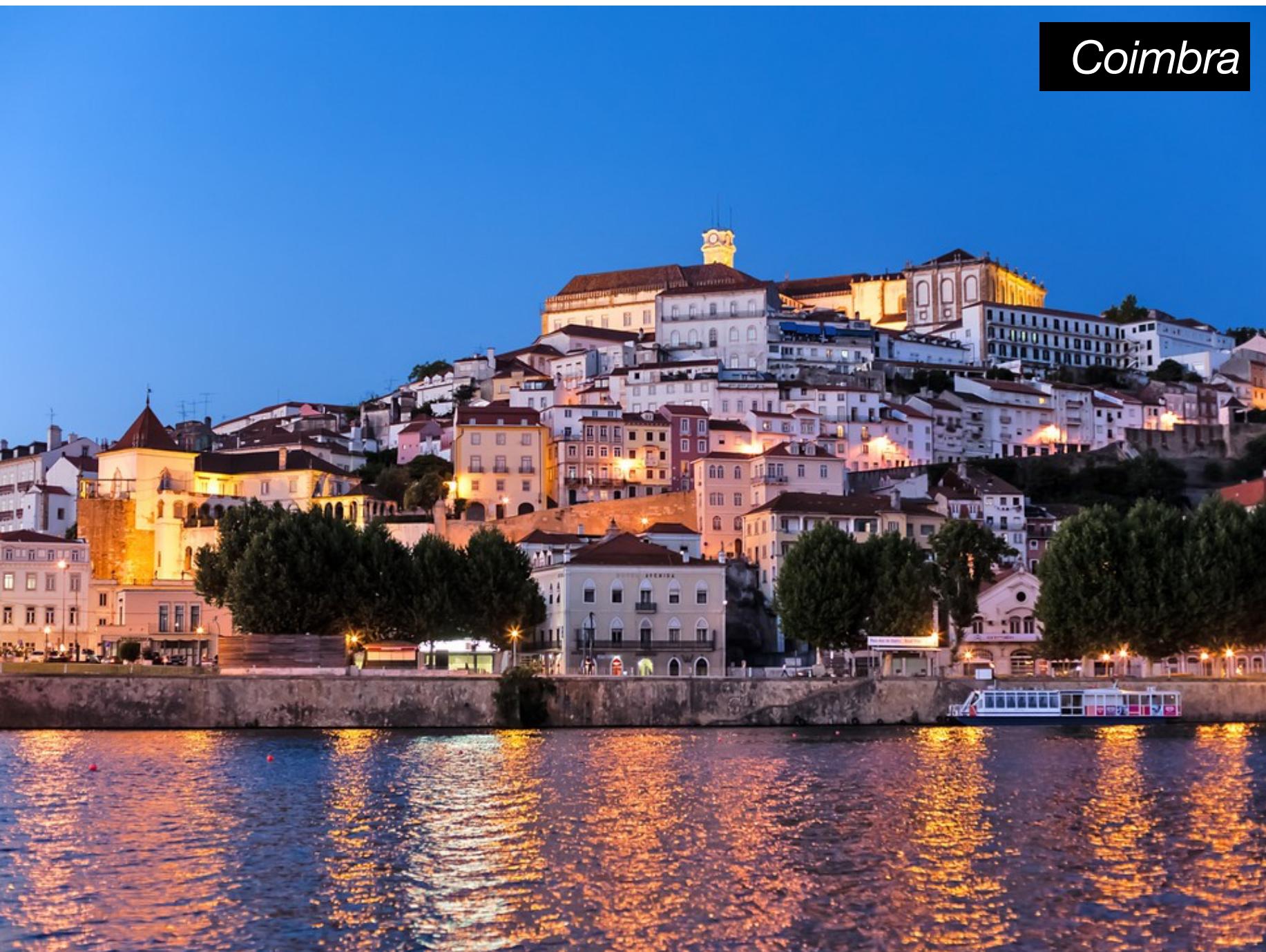
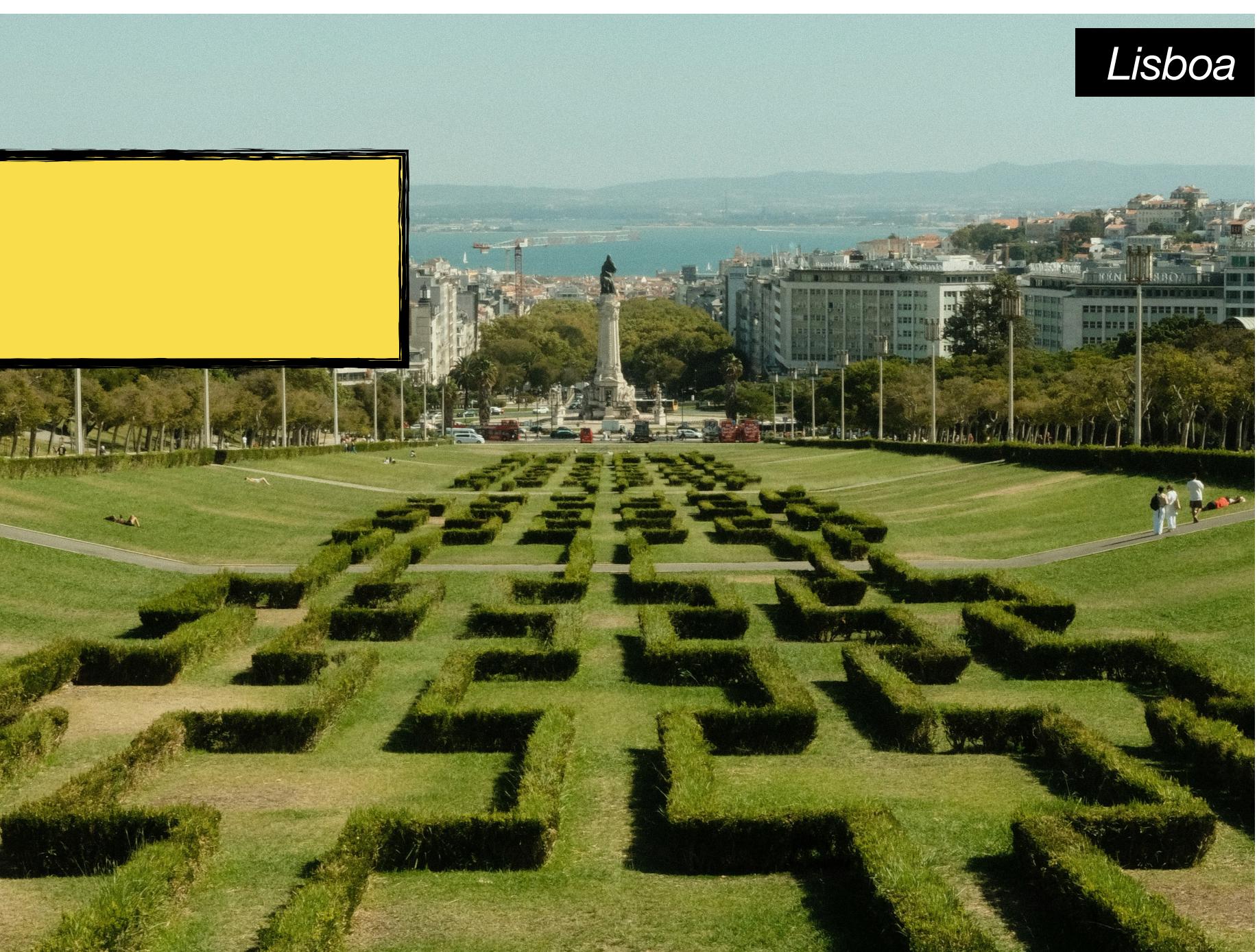
Uma análise de padrões de consumo elétrico através de algoritmos de clustering

From Watts to clusters: Portugal's electricity usage unveiled



Agenda

- Sobre mim
- Objetivo da análise
- Dados (origem e processamento)
- Metodologia
- Resultados
- Conclusão



Um pouco sobre mim

- Algarvio (natural de Faro)
- 2017: Licenciado em Engenharia Mecânica pela Universidade do Algarve (Faro, Portugal)
- 2018: Projectista de sistemas de AVAC e solar térmico (Faro, Portugal)
- 2020: Mestrado em Indoor Environment and Energy Engineering pela AAU (Aalborg, Dinamarca)
- 2024: Doutoramento com o título de tese: From smart meters to diagnostics: Data-driven methodologies for building efficiency assessment within district heating (Aalborg, Dinamarca)
- Presente: Project Lead na Danfoss (Copenhaga, Dinamarca)

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Introdução

O consumo elétrico está a mudar com a transição energética. Hoje vemos não só um maior investimento nas energias renováveis, como também o cidadão comum está a voltar-se para outros sistemas de consumo energético diferente (ex: carros elétricos)

Portugal destaca-se a nível europeu na produção de energias renováveis.

Mas com estas mudanças, é necessário compreender padrões de consumo para ajudar políticas e planeamento energético do país.



Objetivos

O objetivo principal desta fase do trabalho foi aplicar um método de *clustering* às medições mensais de consumo de eletricidade de todos os municípios de Portugal.

Através desta análise procurou-se:

- Agrupar municípios com comportamentos de consumo semelhantes ao longo do ano;
- Detetar padrões sazonais (picos no inverno ou verão, consumo estável, quebras sazonais, etc.);
- Avaliar a existência de tendências regionais, analisando se os grupos formados correspondem a áreas geográficas ou distritos específicos.



Santarém

Dados

Origem e processamento

Etapa mais demorada do projeto – como é habitual em *Data Science*.

Principais etapas do algoritmo:

- Importação de múltiplos *datasets*:
 -  Consumo elétrico (E-REDES)
 -  Códigos postais (GitHub and Data Science for Social Good Portugal)
 -  Consumo por utilizador final (indústria, doméstico, etc.), poder de compra e população (PORDATA)
- Limpeza dos códigos postais (remoção de dígitos desnecessários e duplicados).
- Correção de nomes de concelhos e adição manual de coordenadas (latitude/longitude) em falta.
- Obtenção de geocódigos dos concelhos e remoção de registo sem localização.
- Filtragem dos dados de eletricidade para incluir apenas códigos postais com medições completas (12 meses).
- Normalização do consumo energético (cálculo do z-score).
- Junção dos dados geográficos e socioeconómicos: indústria, consumo, poder de compra e população.



Metodologia

Clustering

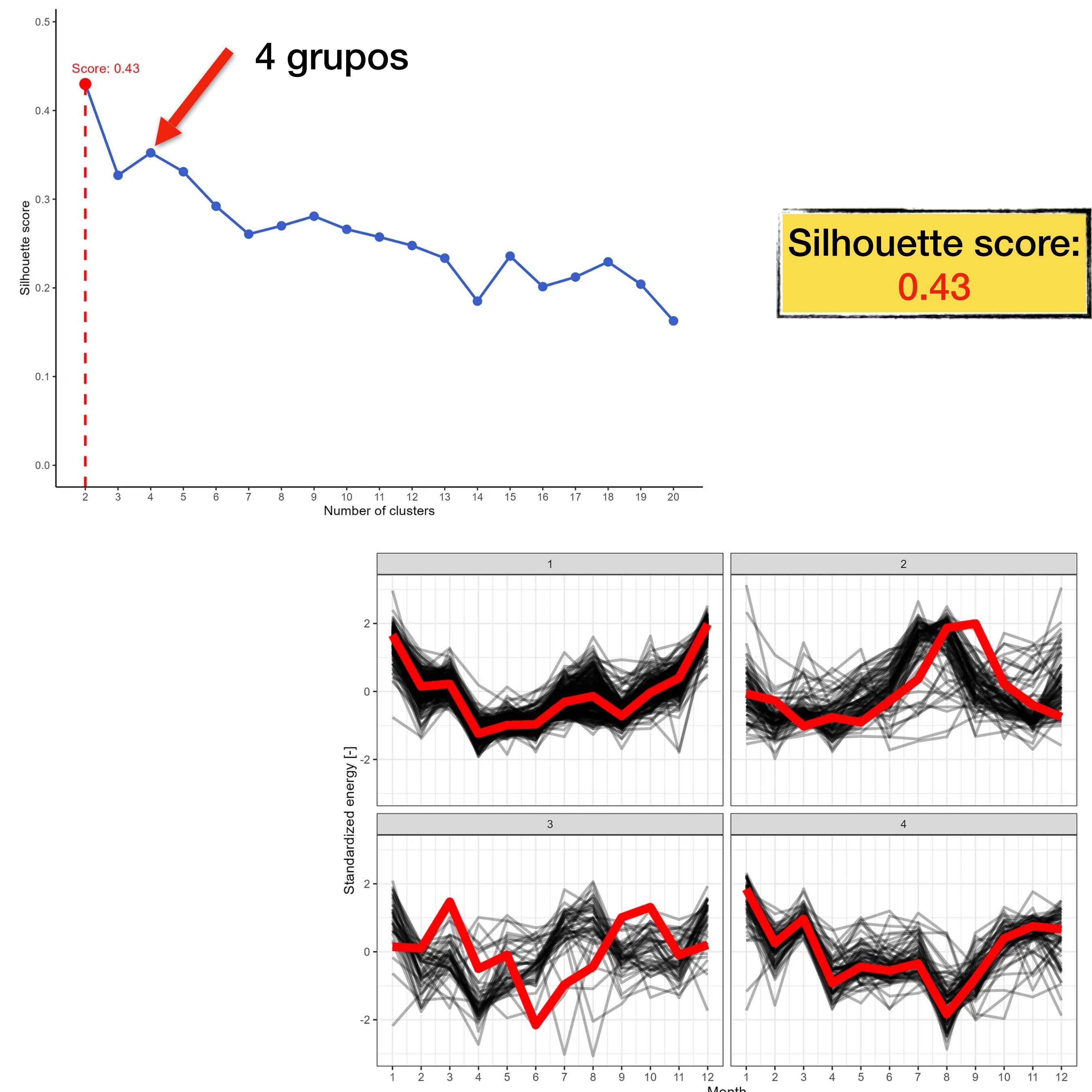
Algoritmo: k-Shape

É um algoritmo não supervisionado, logo parte-se do princípio que não sabemos número de grupos que existem.

Para descobrir o melhor número de grupos, usei silhouette score, em que o valor máximo indica melhor número grupos.

- Neste caso: 2, mas eu usei 4 (segundo valor máximo).

Com 4 grupos, vemos que existem alguns municípios que tem um padrão diferente comparativamente todos os outros grupos (outliers).



Metodologia

Clustering

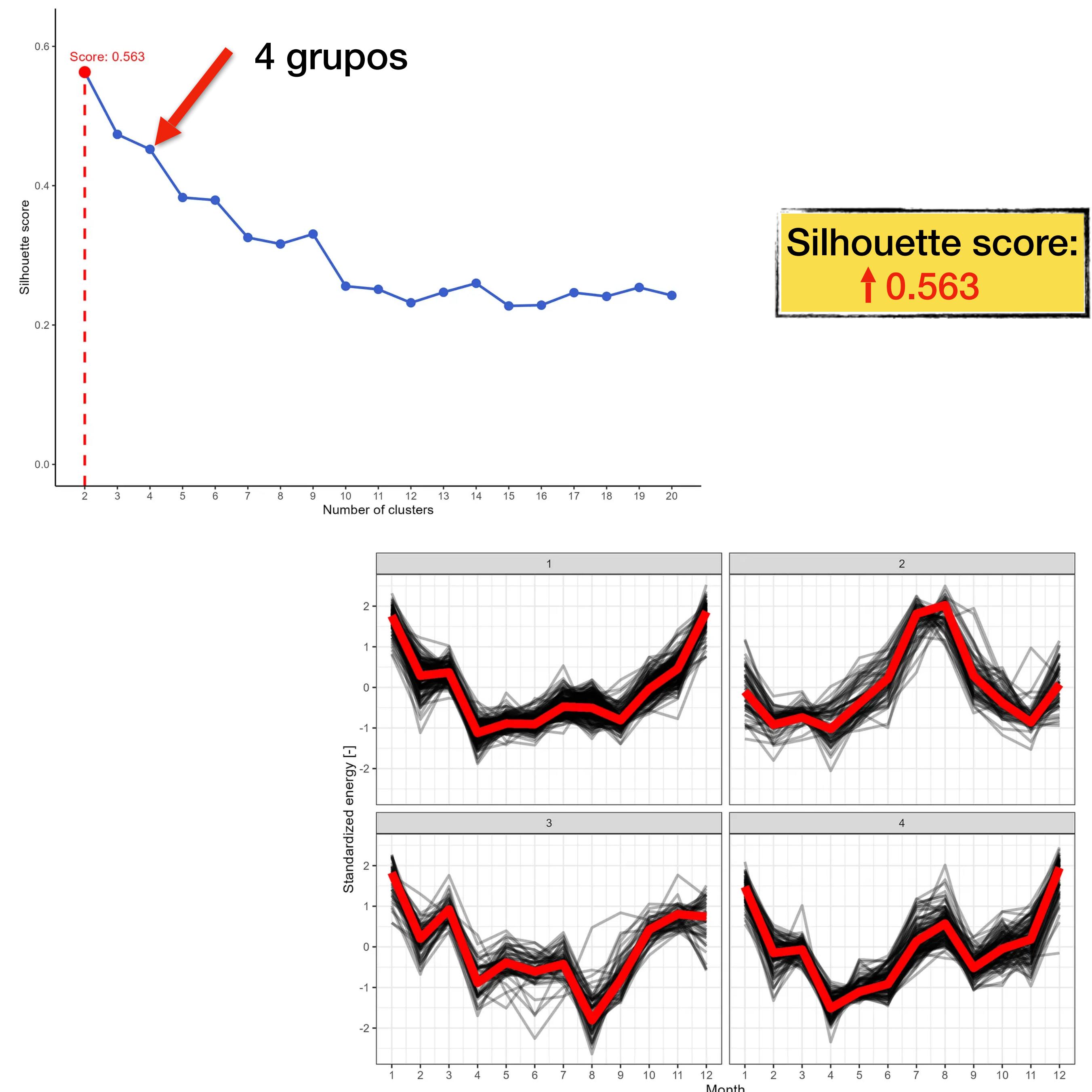
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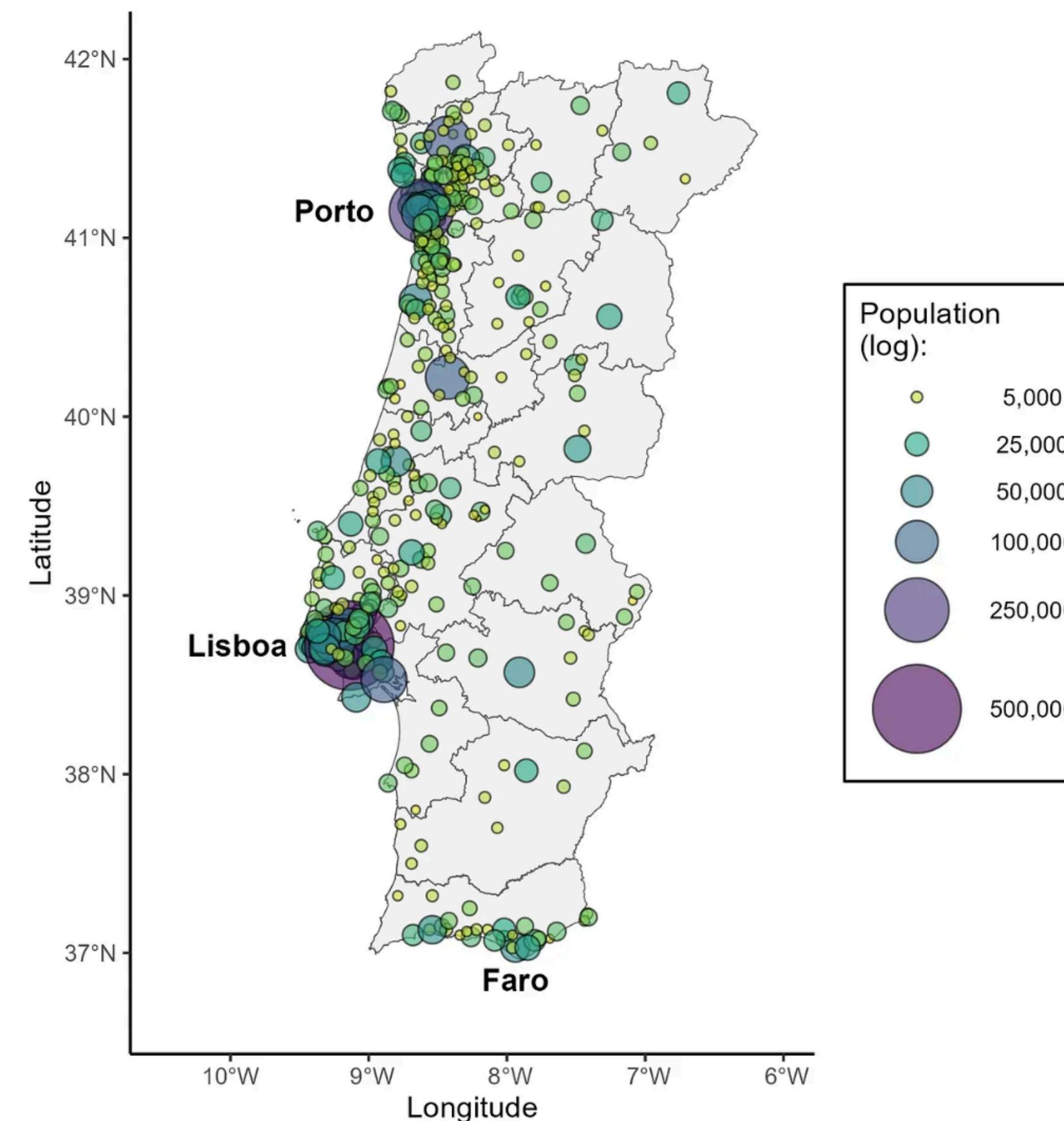
- Neste caso: 2, mas eu usei 4 (segundo valor máximo).

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— Removidos e categorizados como Cluster 5

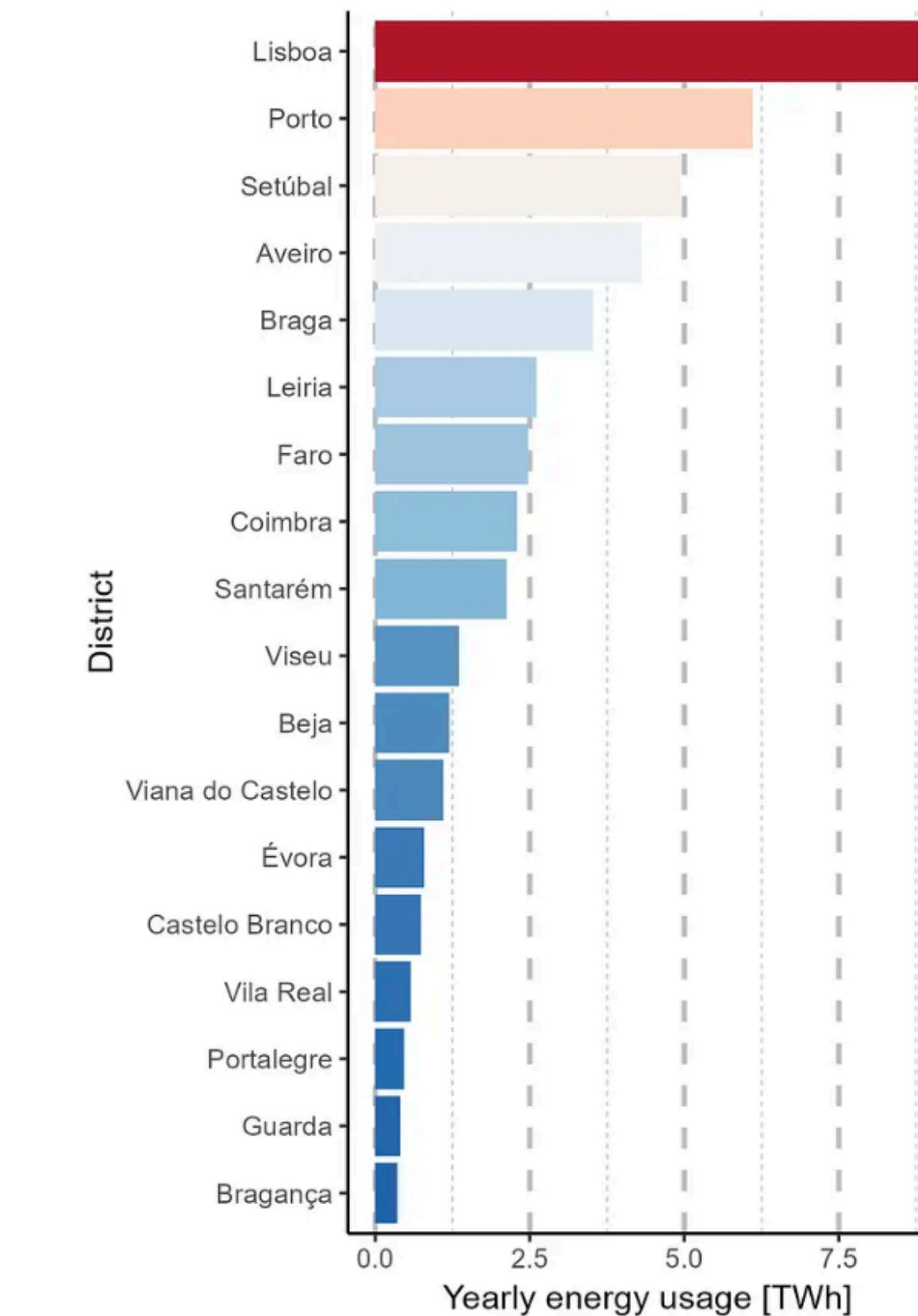


Resultados

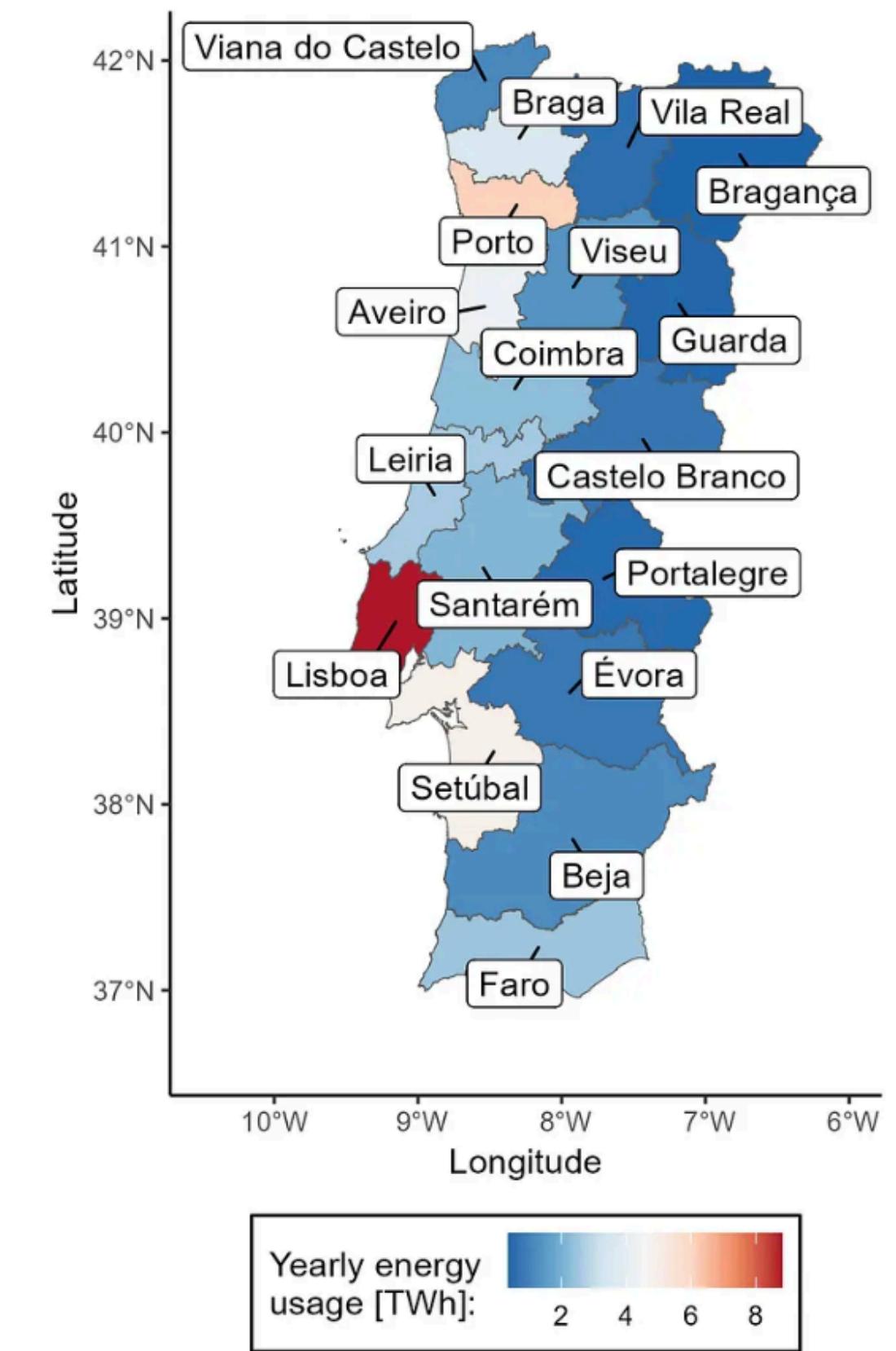
Análise de dados



Concentração populacional

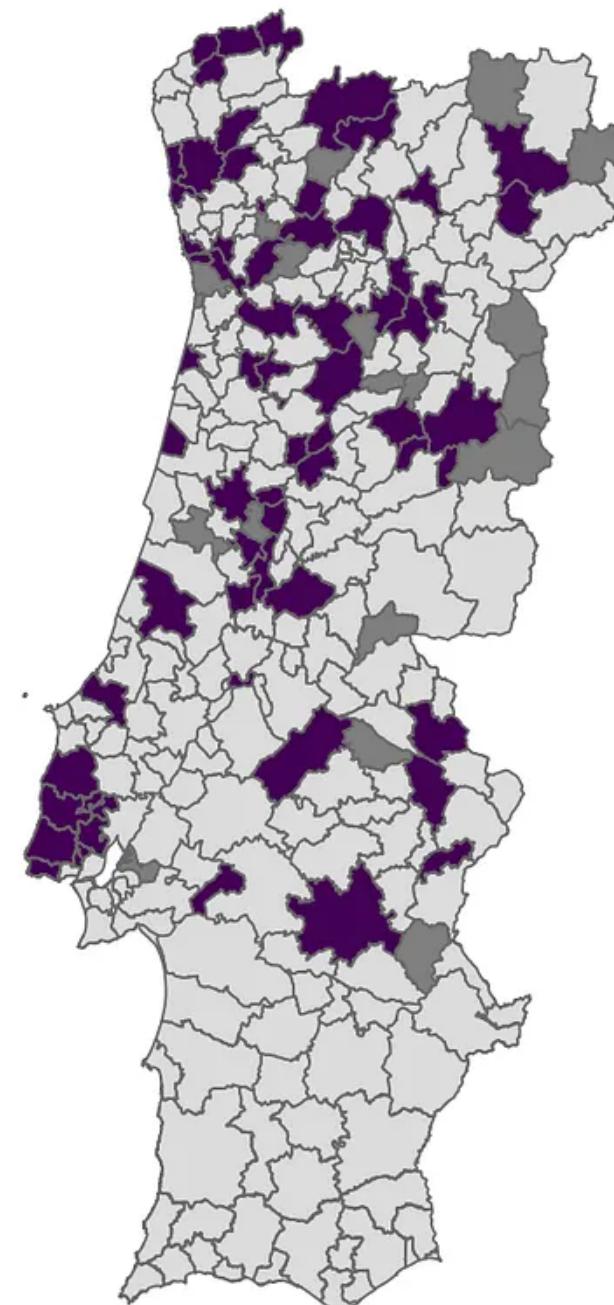


Consumo energético por distrito

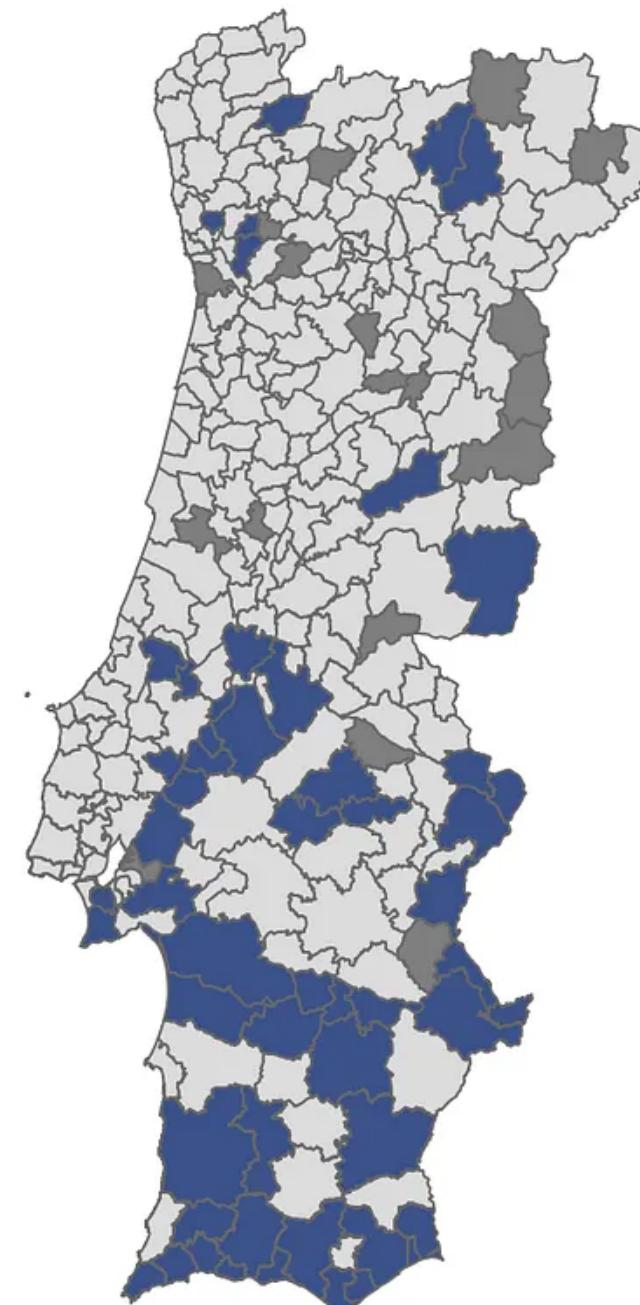


Resultados

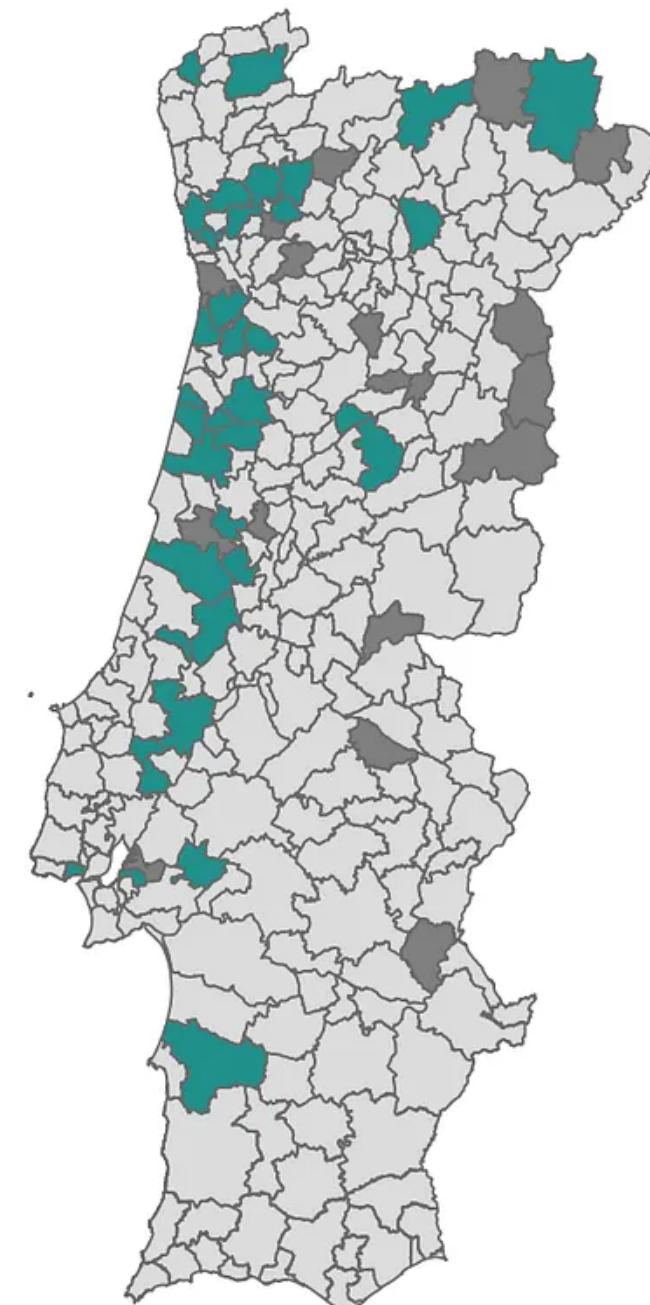
Cluster 1



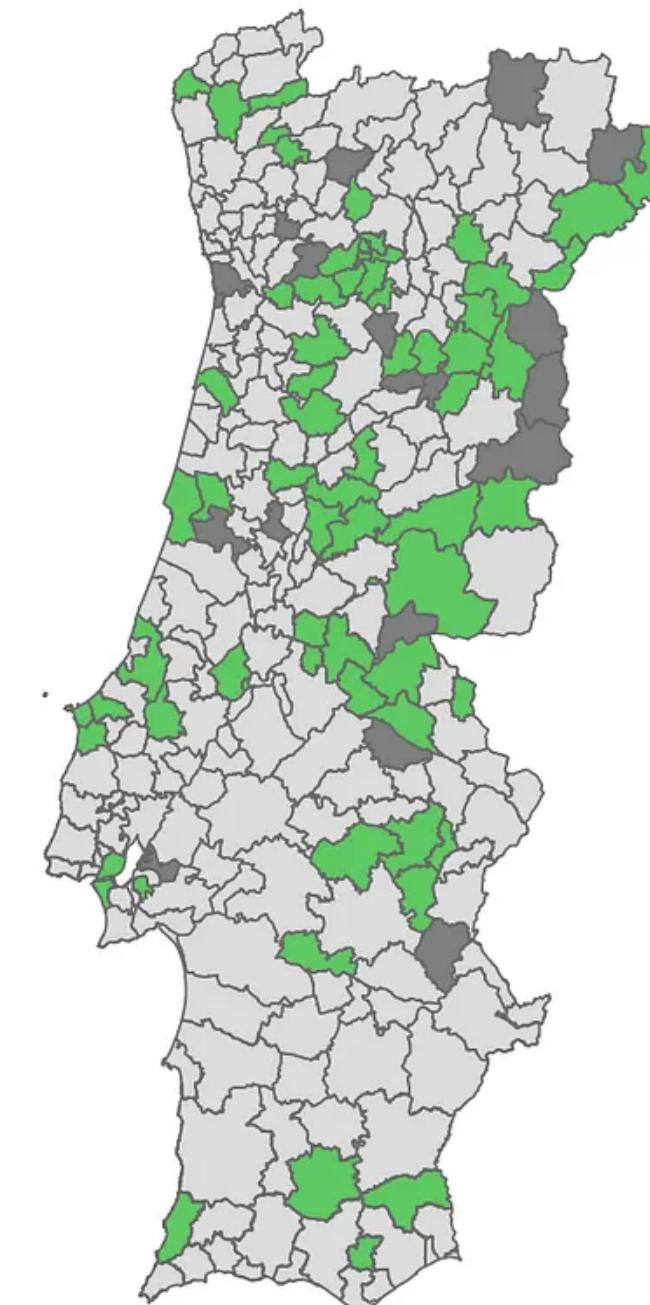
Cluster 2



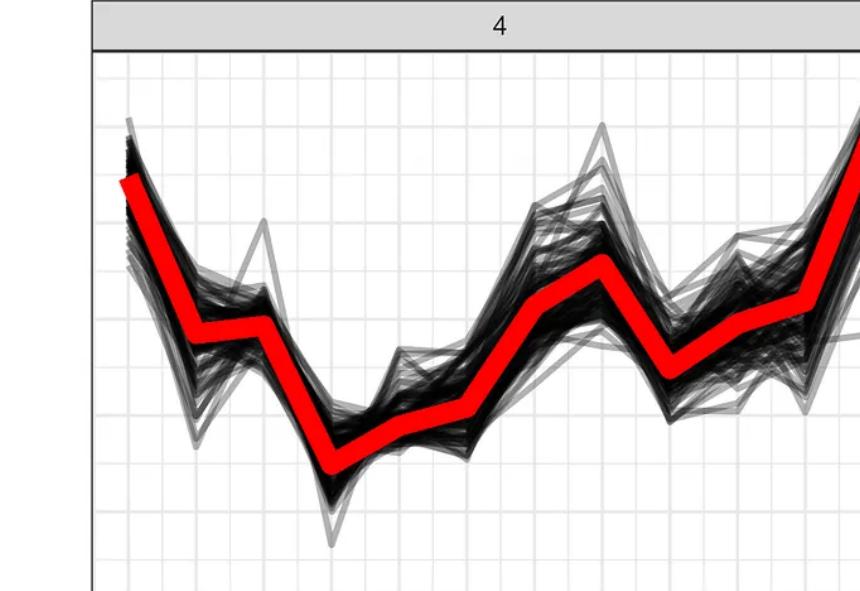
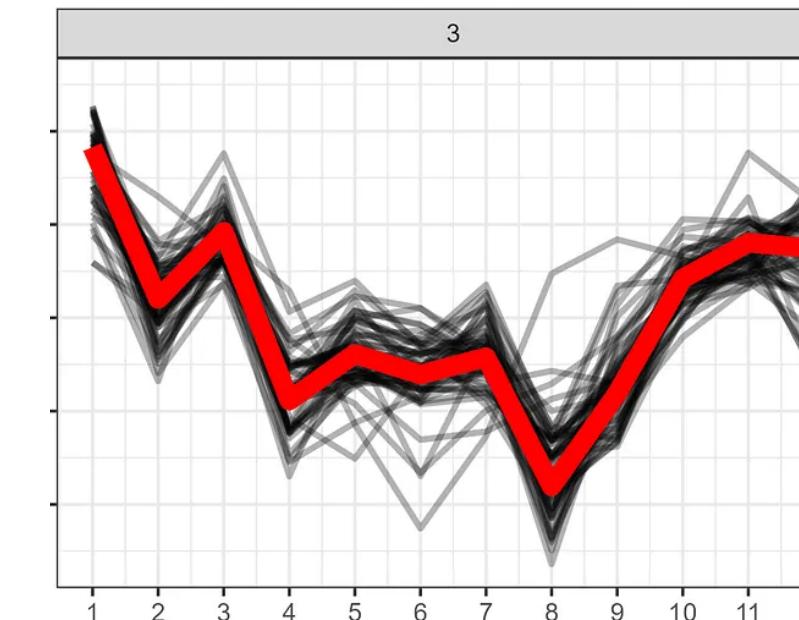
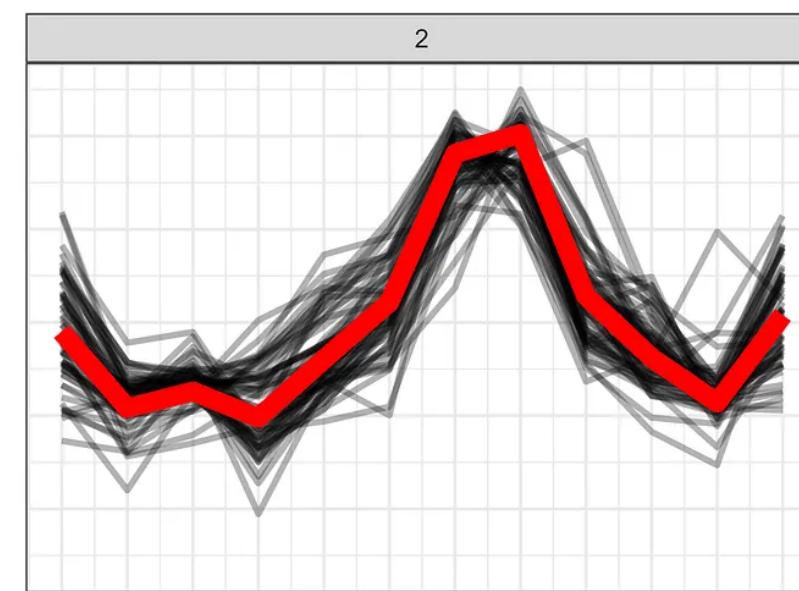
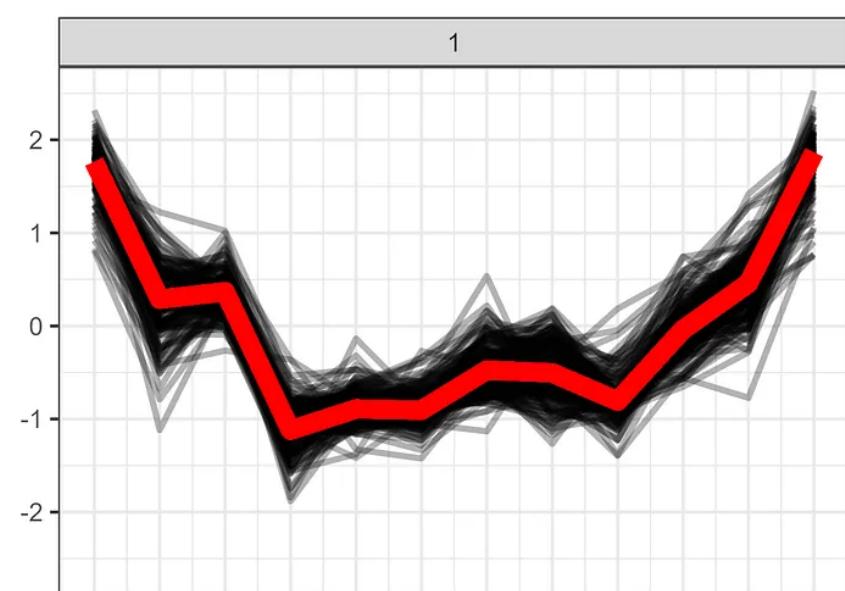
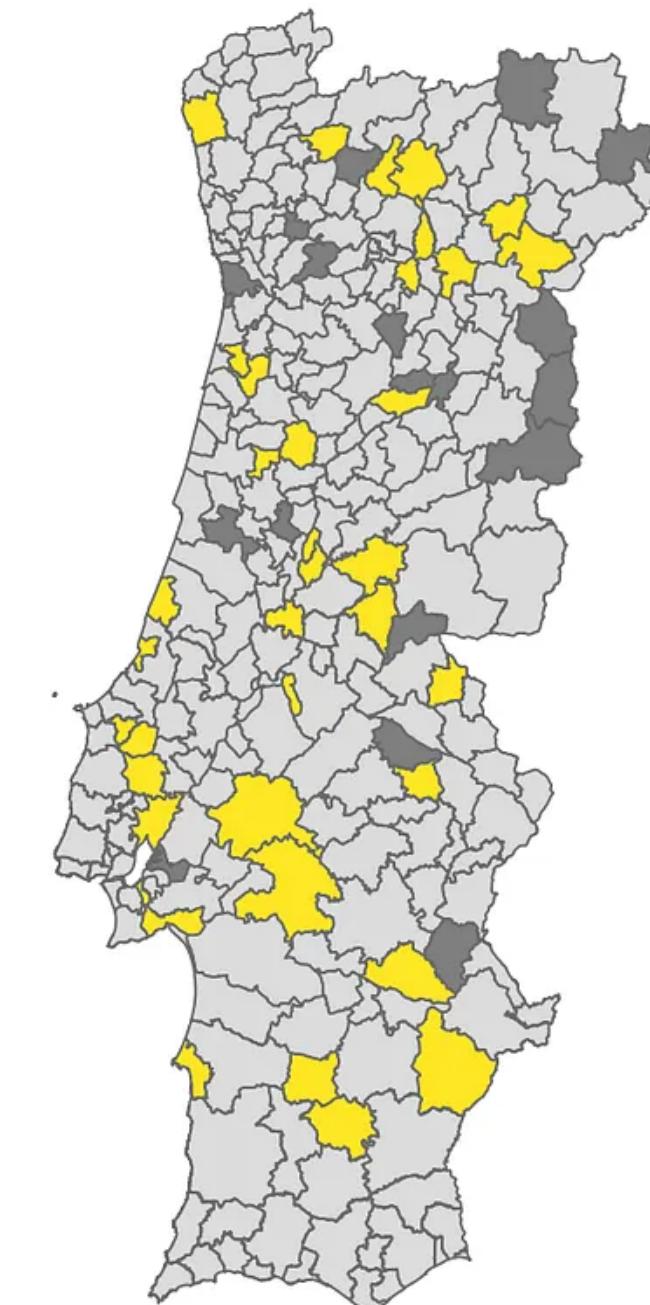
Cluster 3



Cluster 4

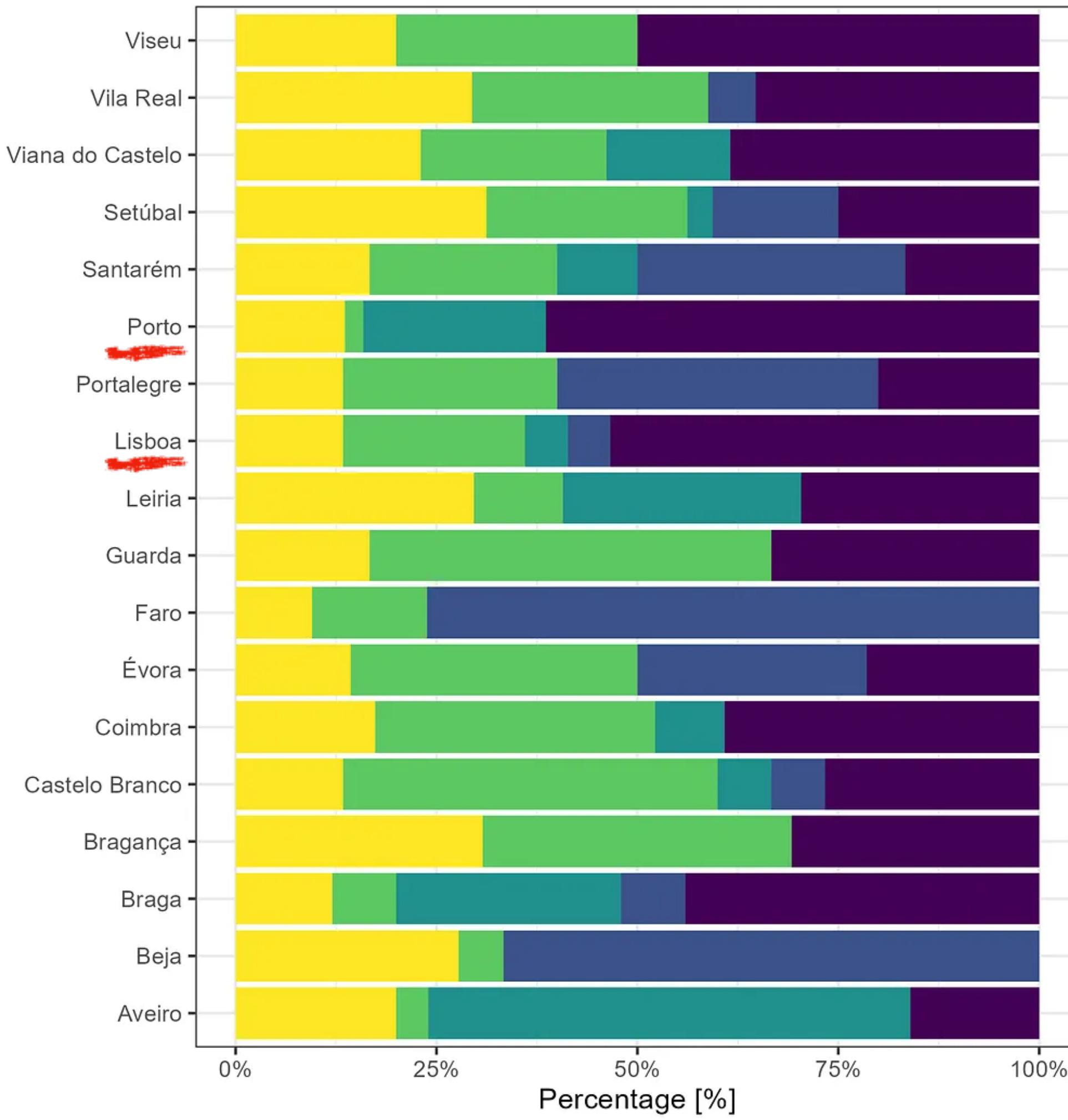
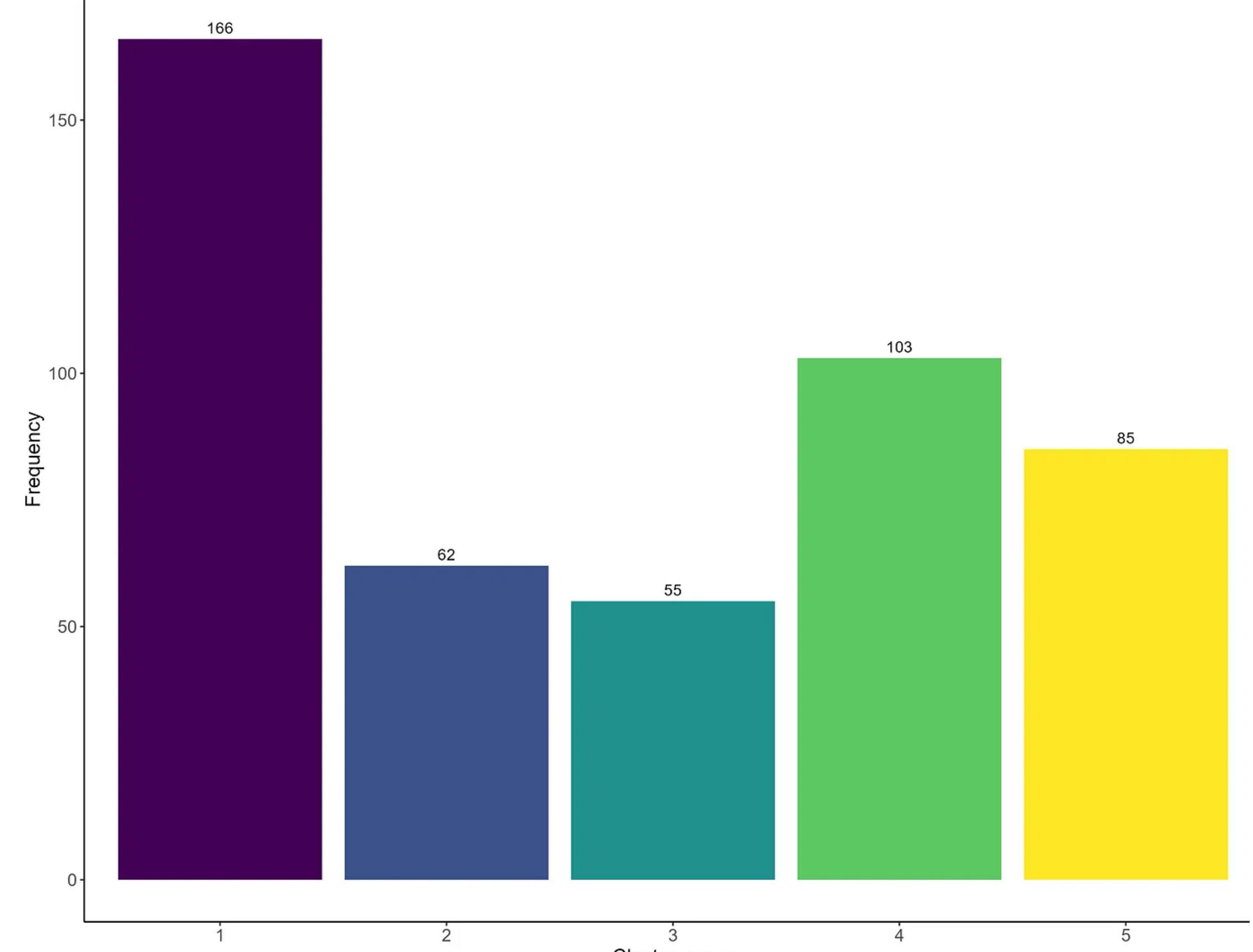


Cluster 5

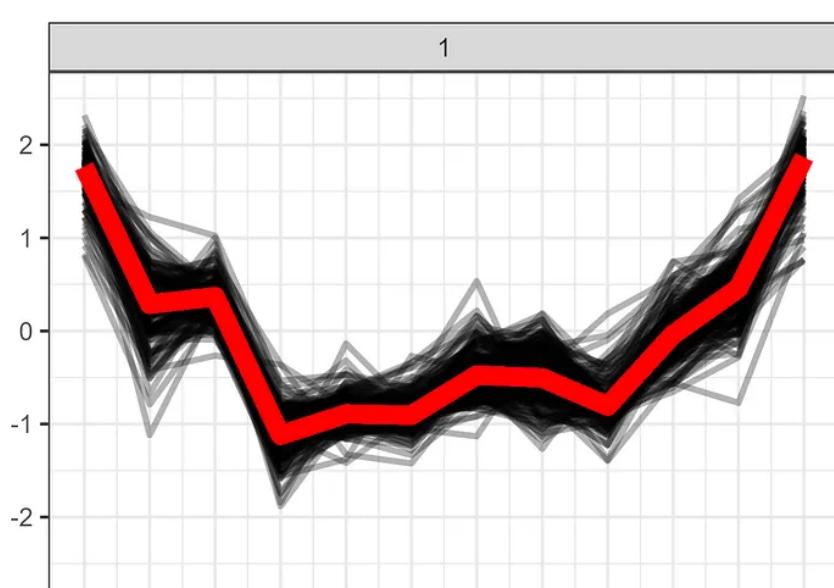
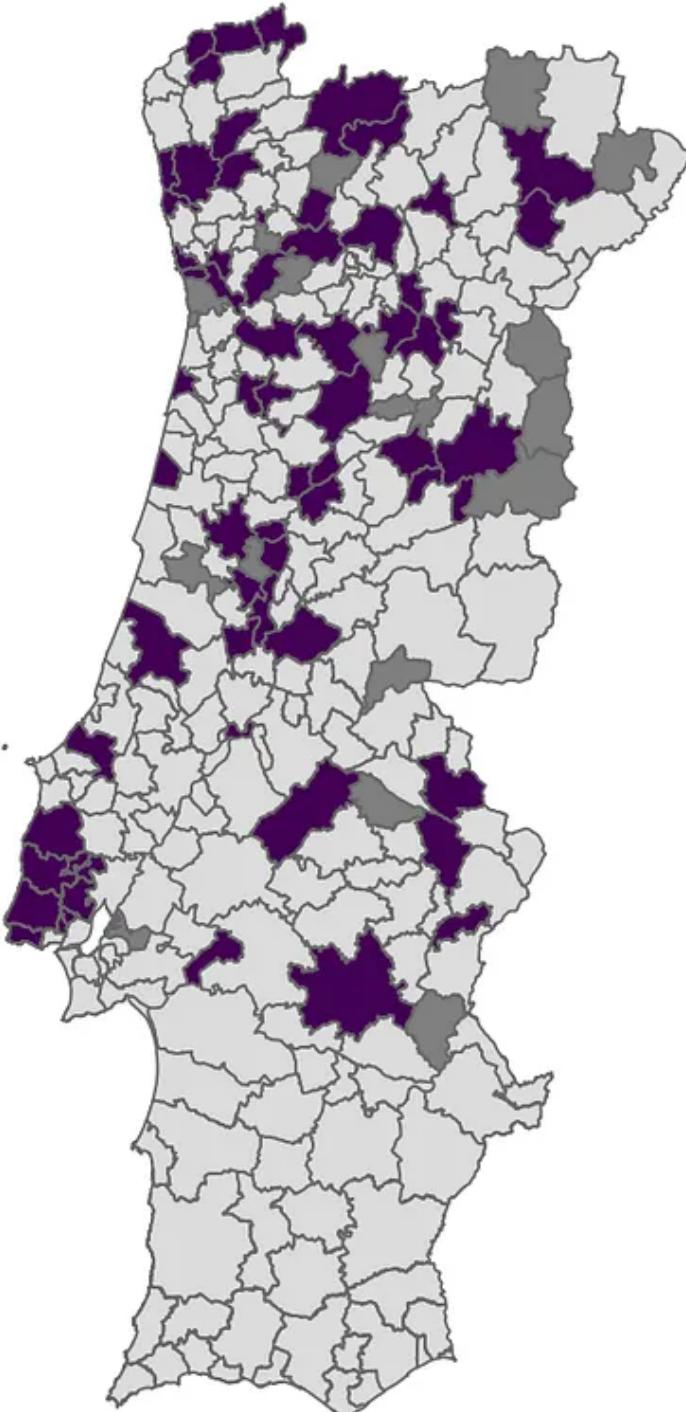


**Valores Atípicos
(Outliers)**

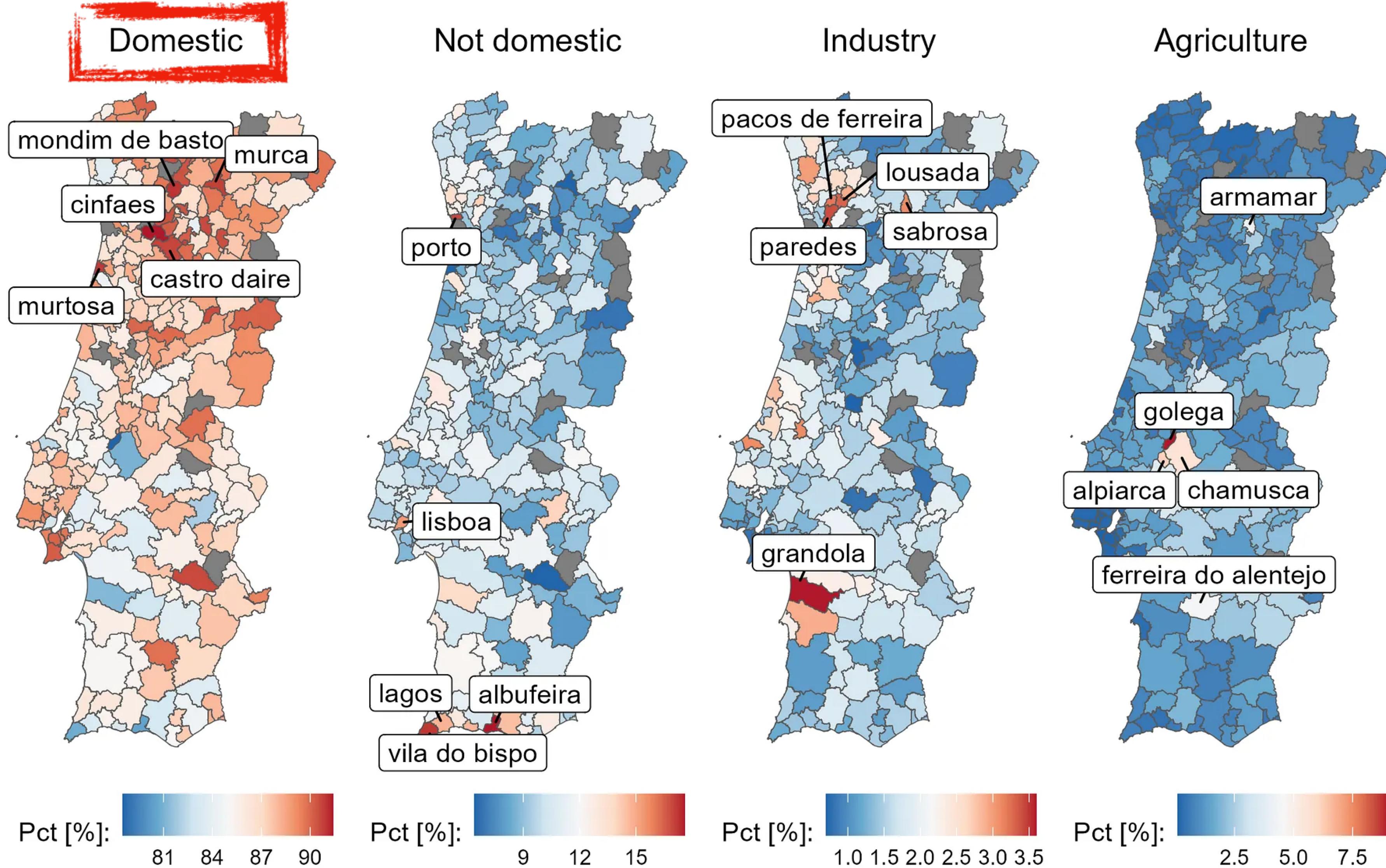
Resultados



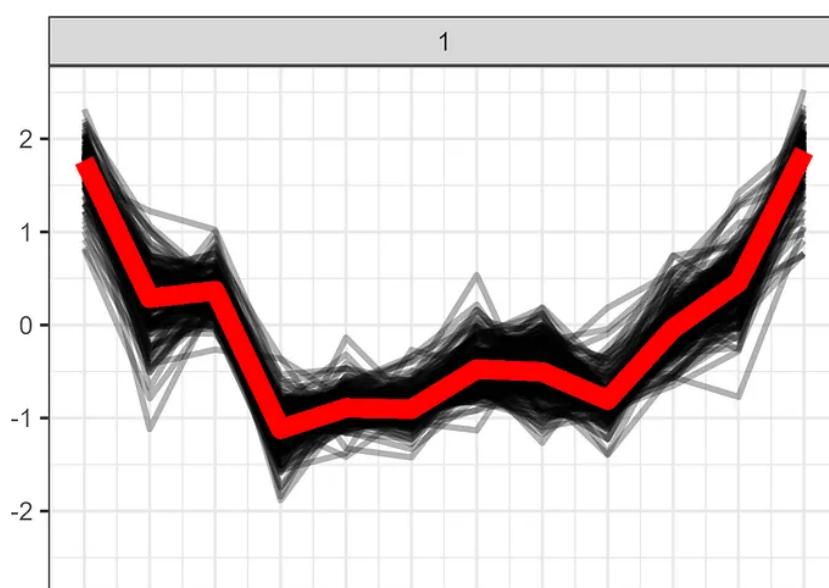
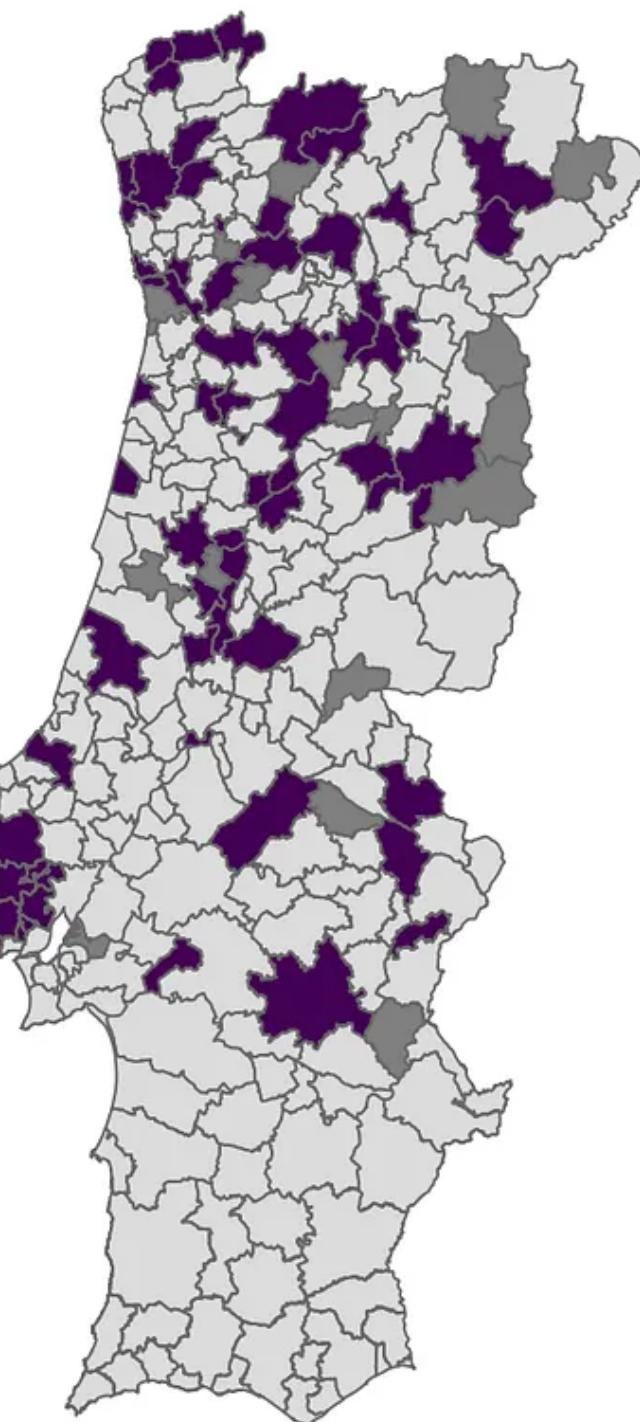
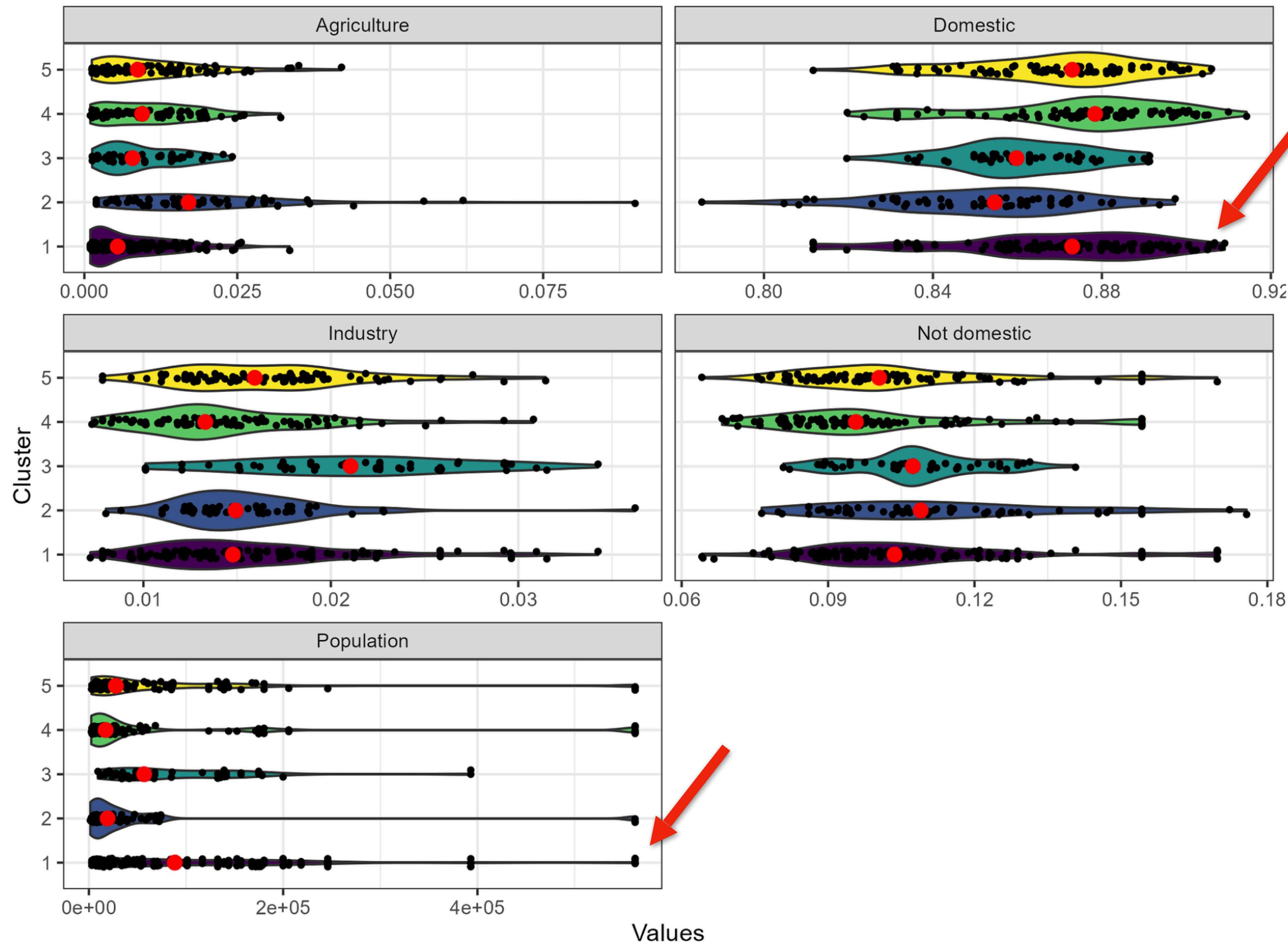
166 códigos



Resultados

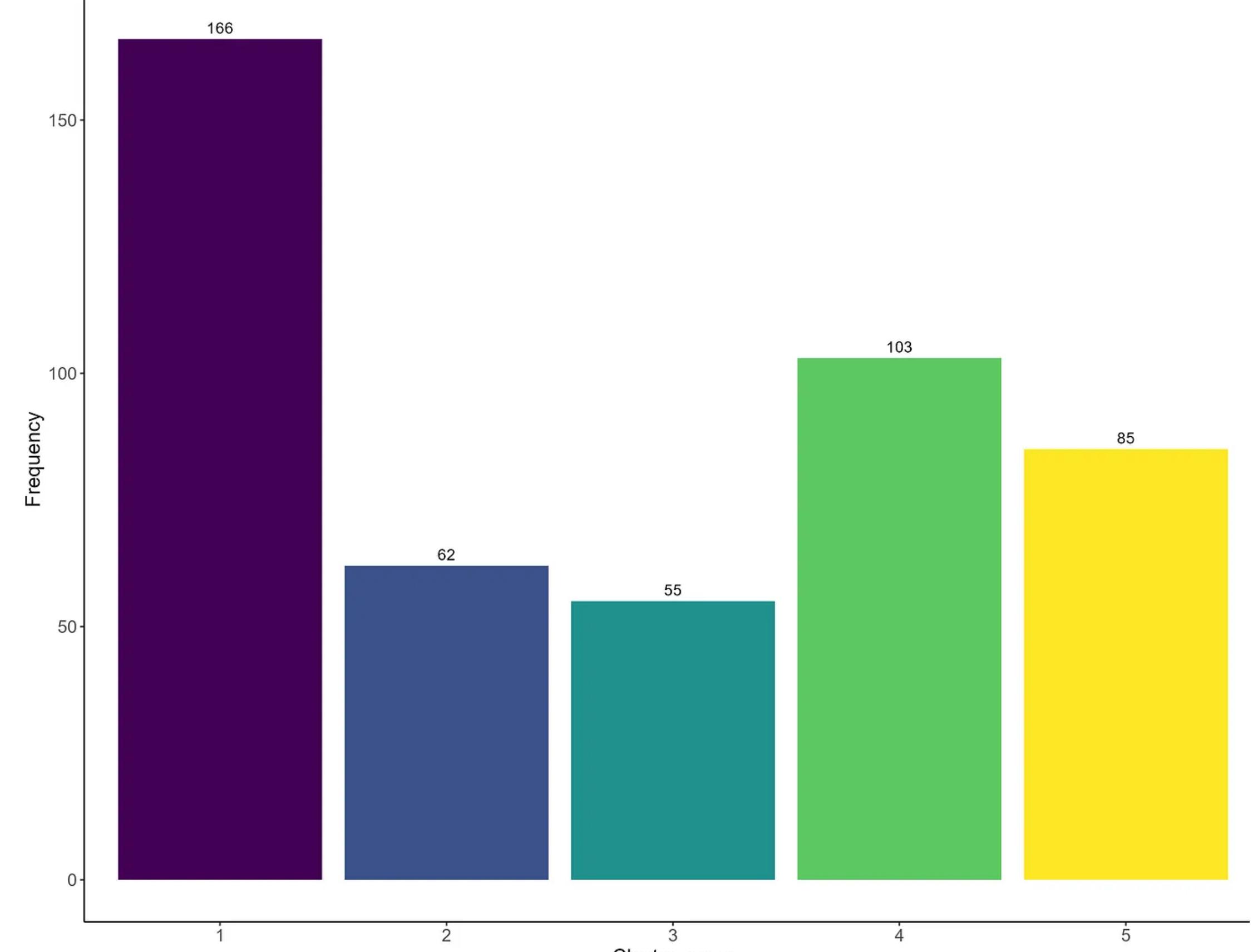


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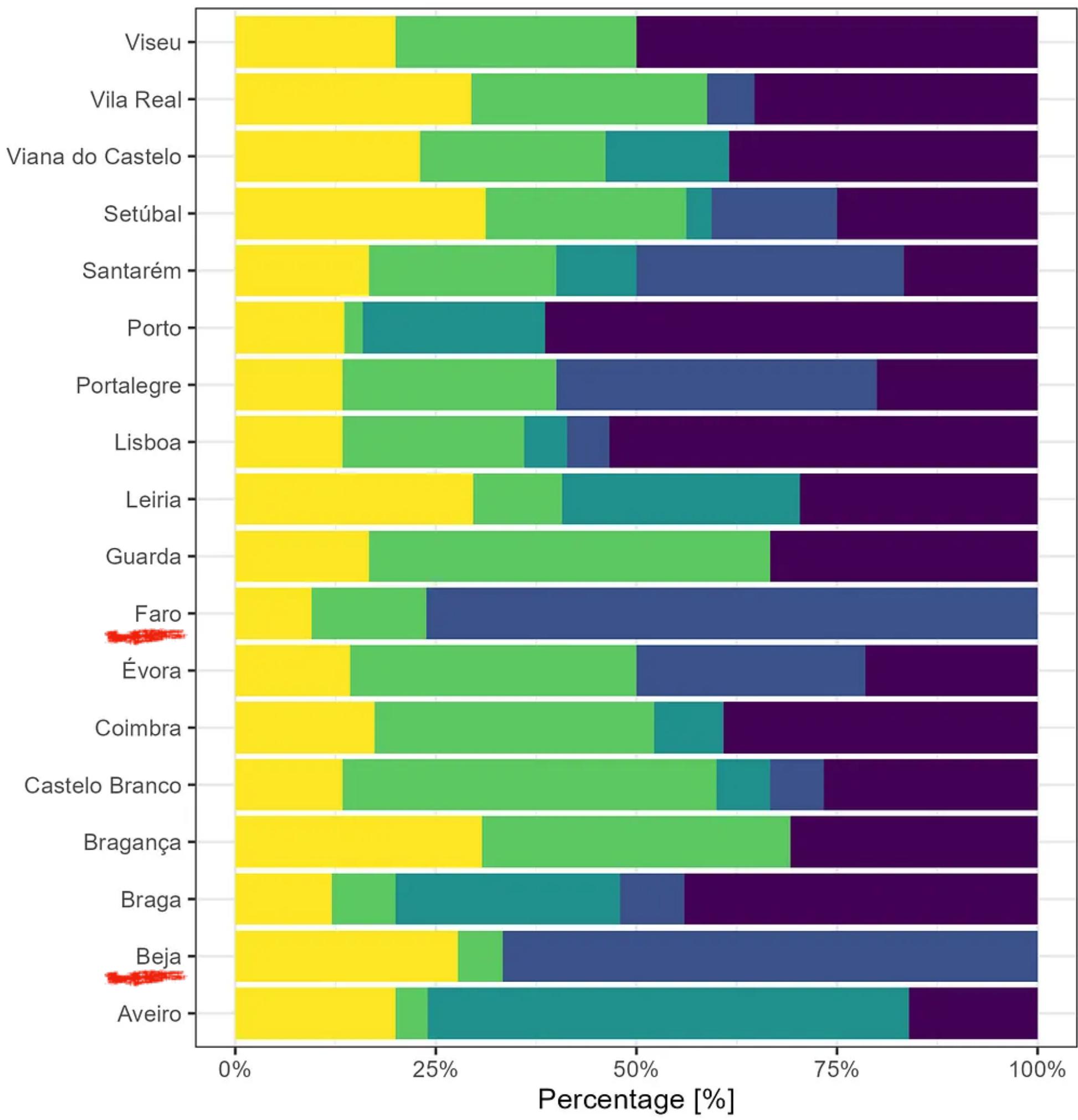


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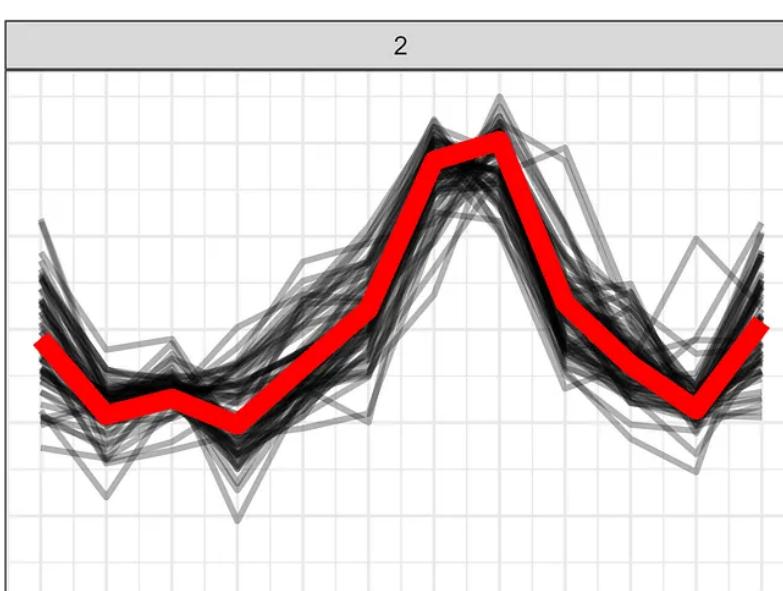
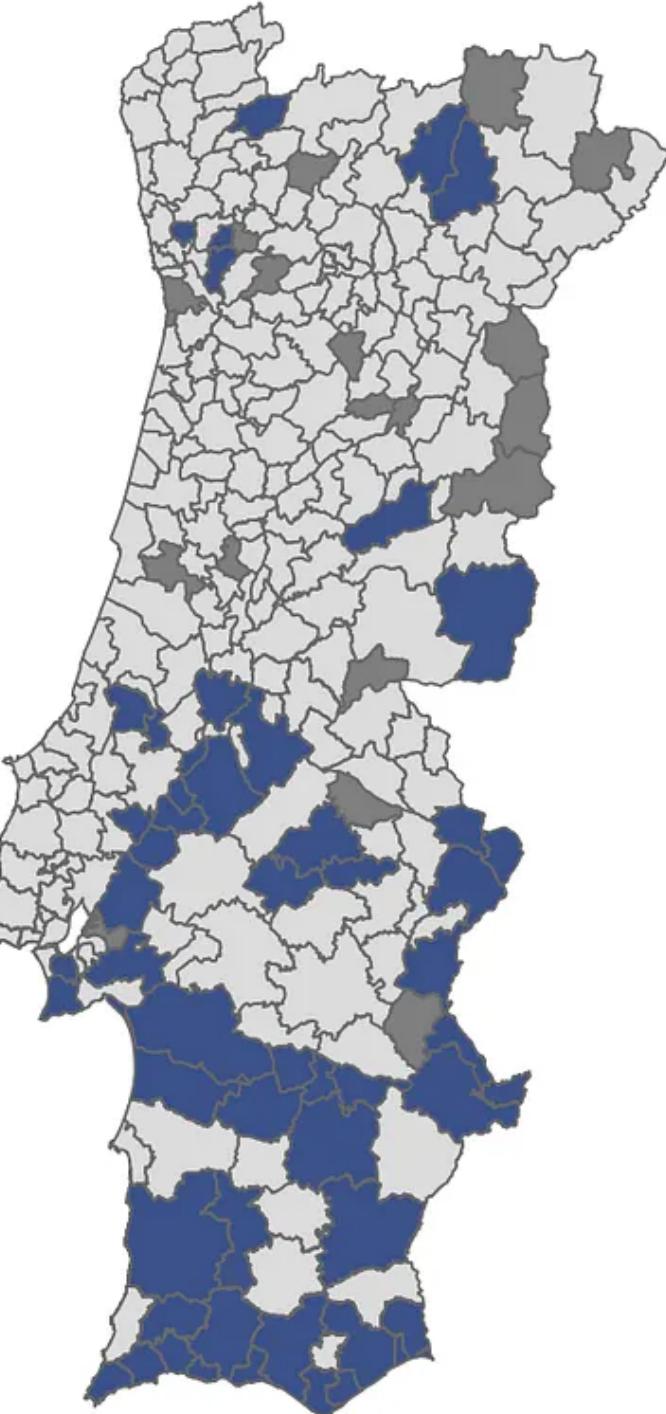
Resultados



Type of pattern: █ Winter peak (1) █ Summer peak (2) █ Summer break (3) █ Winter/Summer peaks (4) █ Outlier (5)

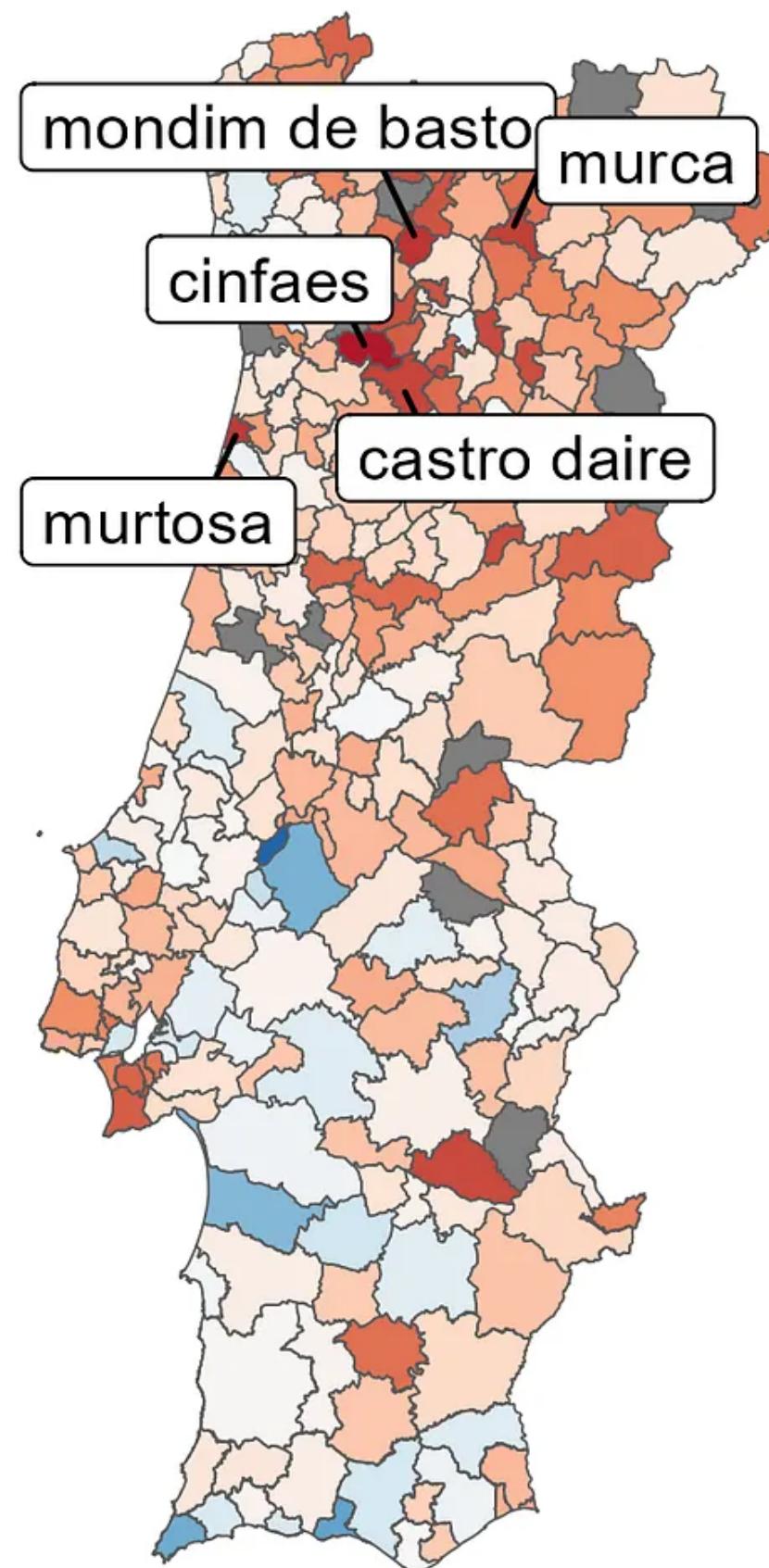


62 códigos

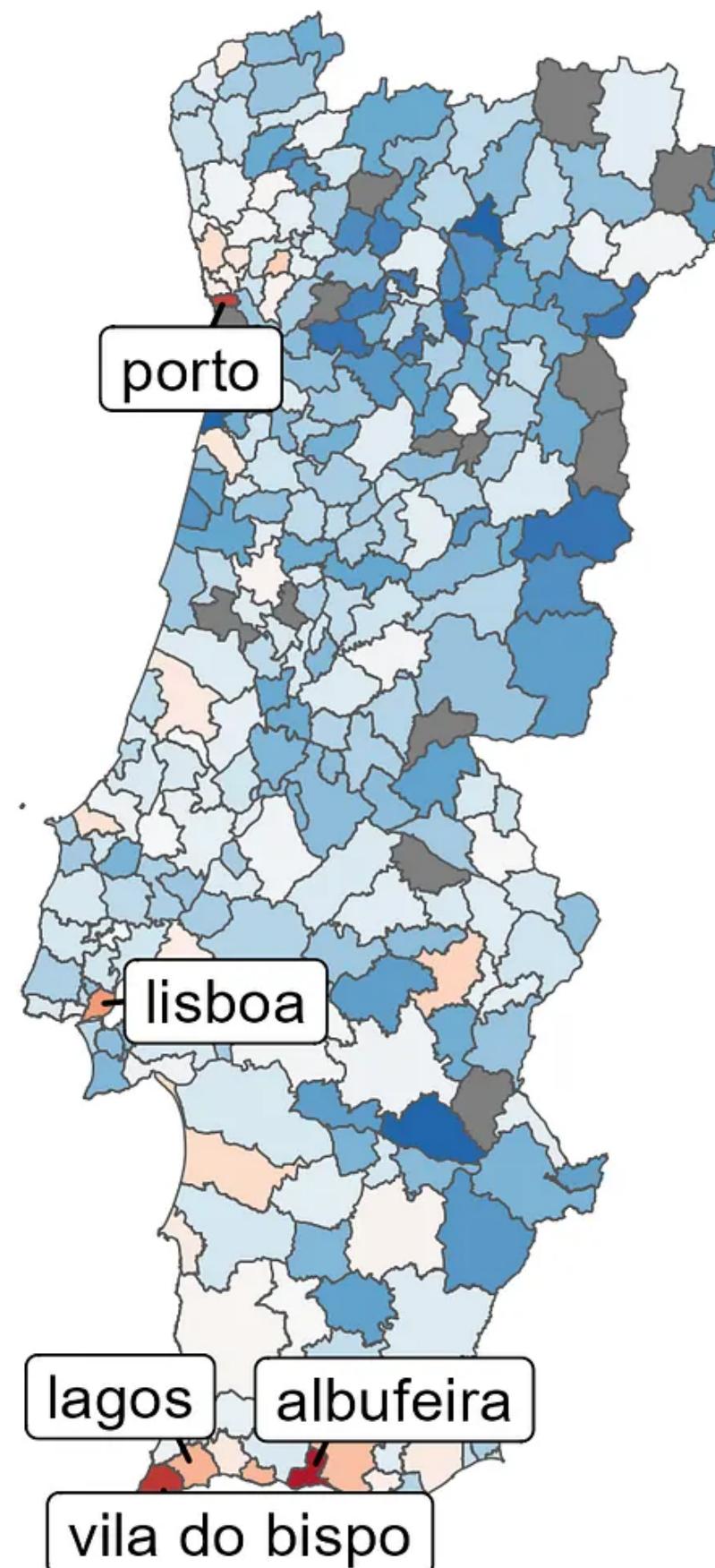


Resultados

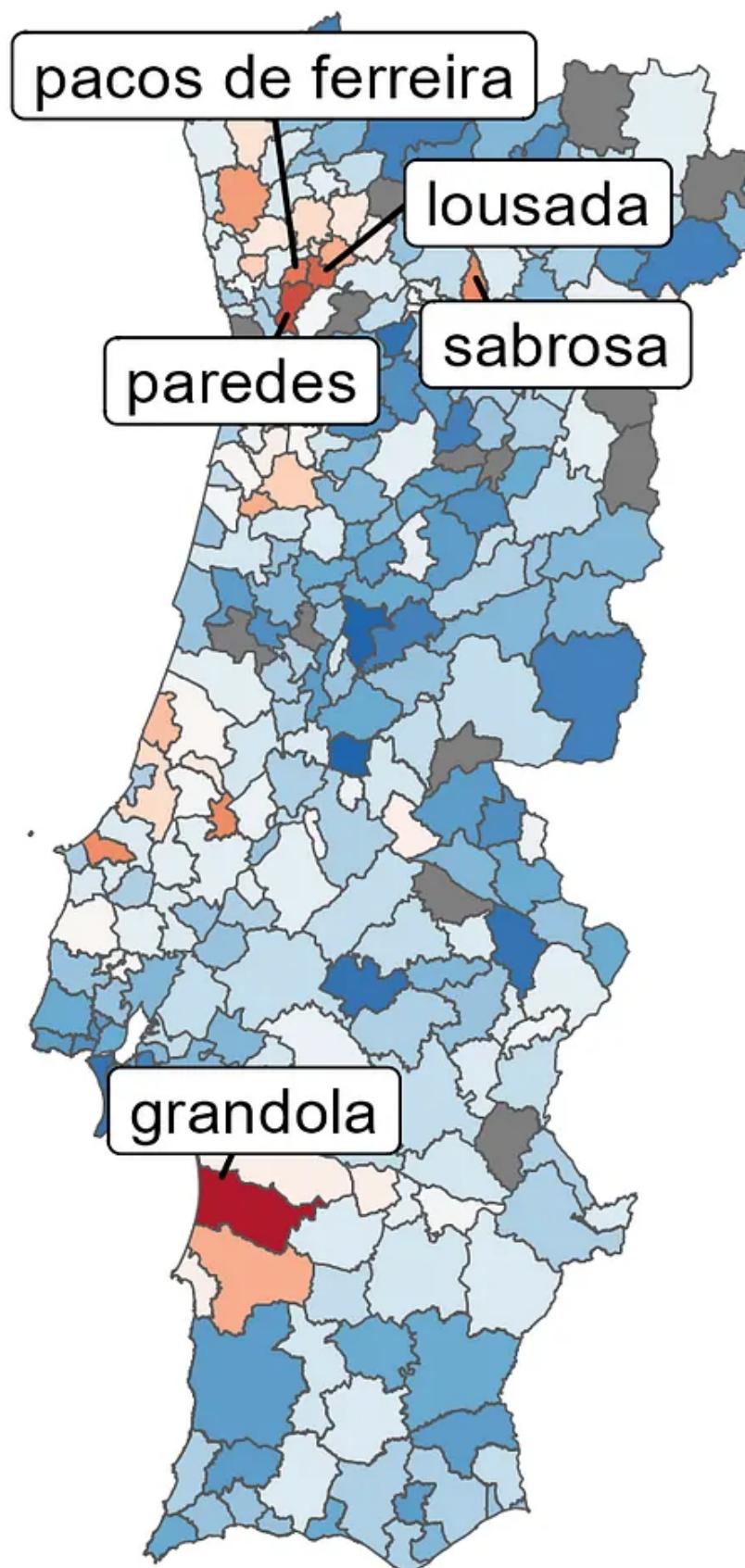
Domestic



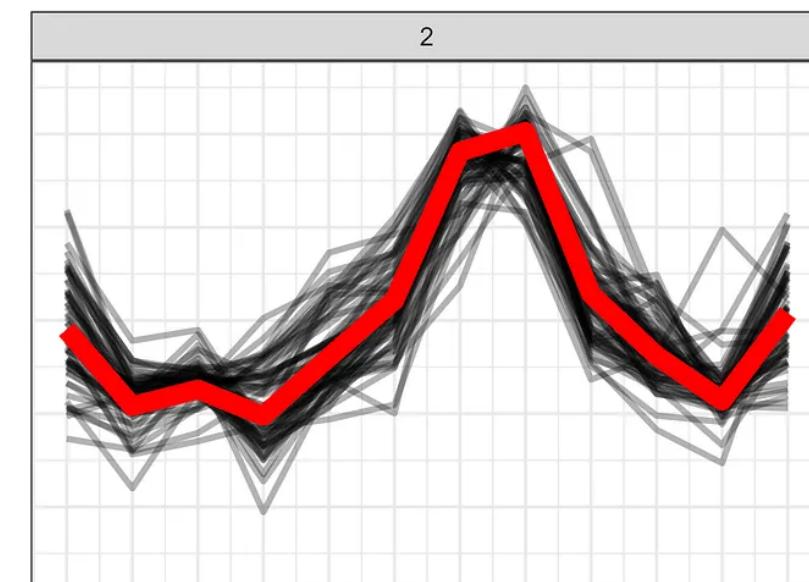
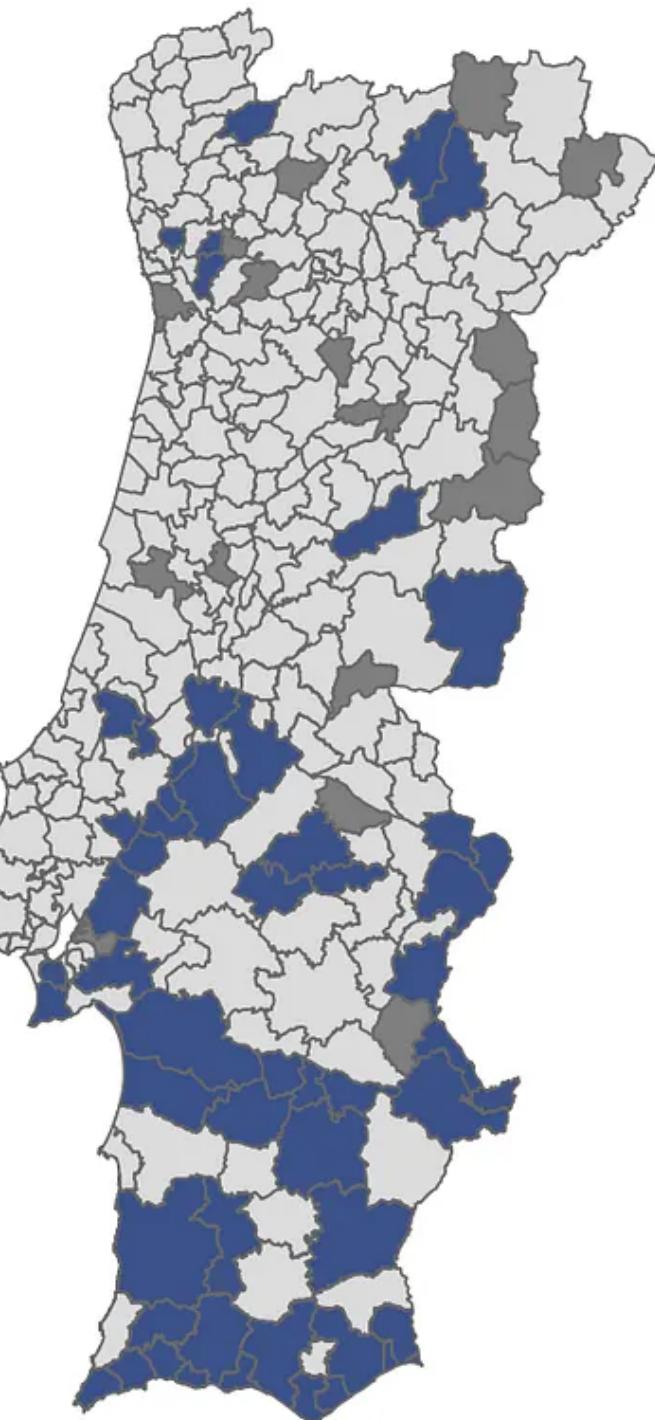
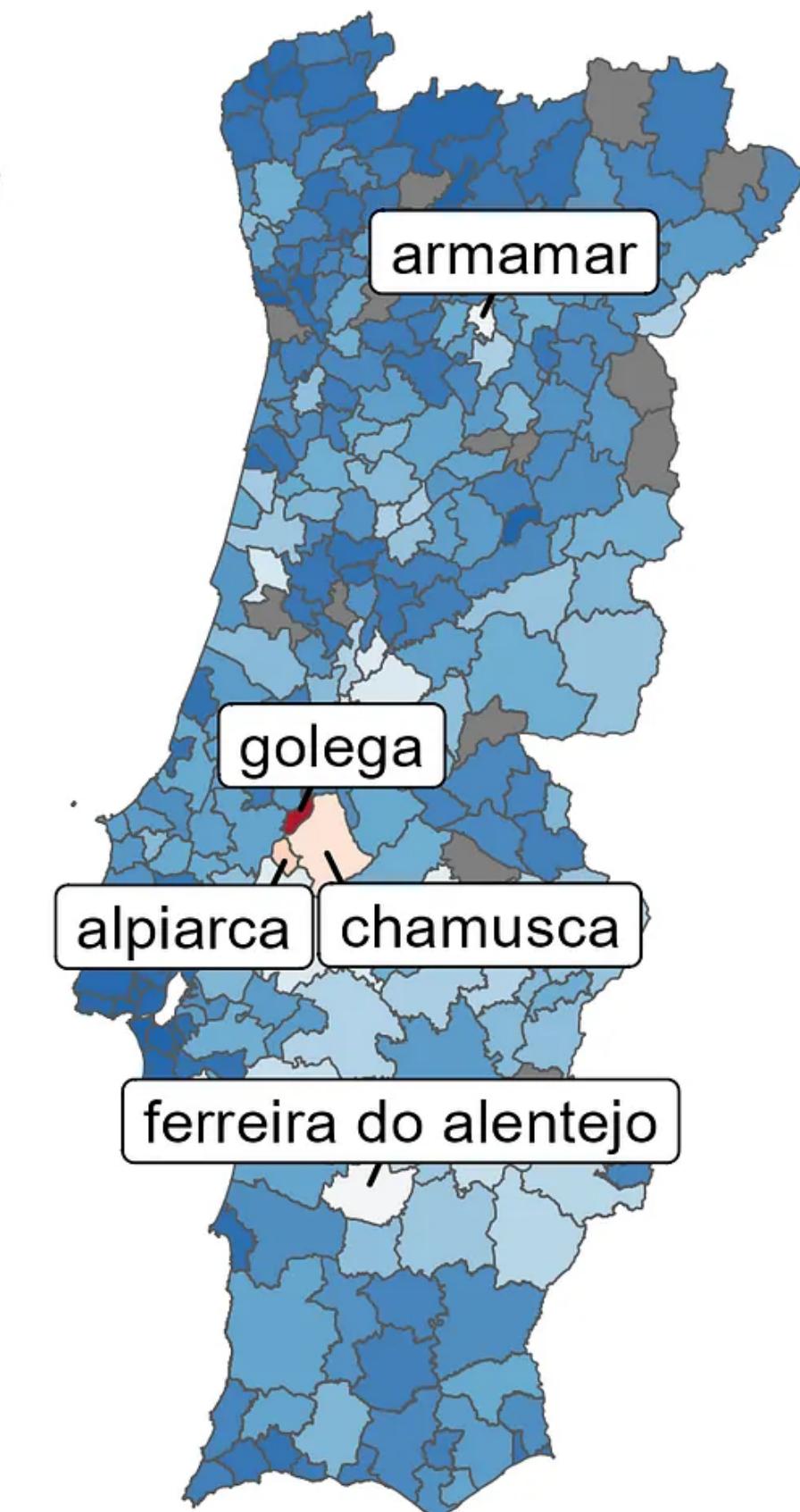
Not domestic



Industry

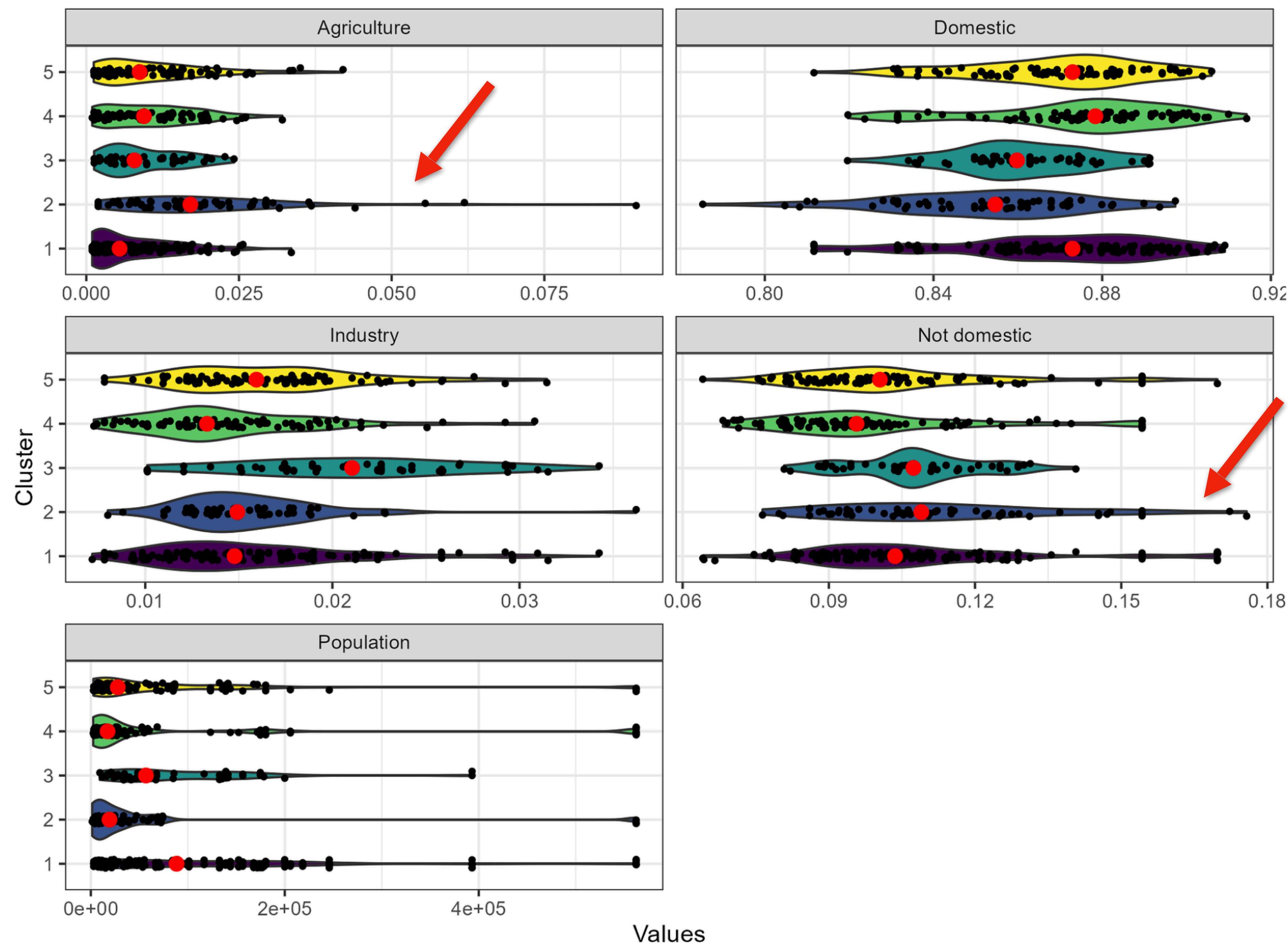


Agriculture

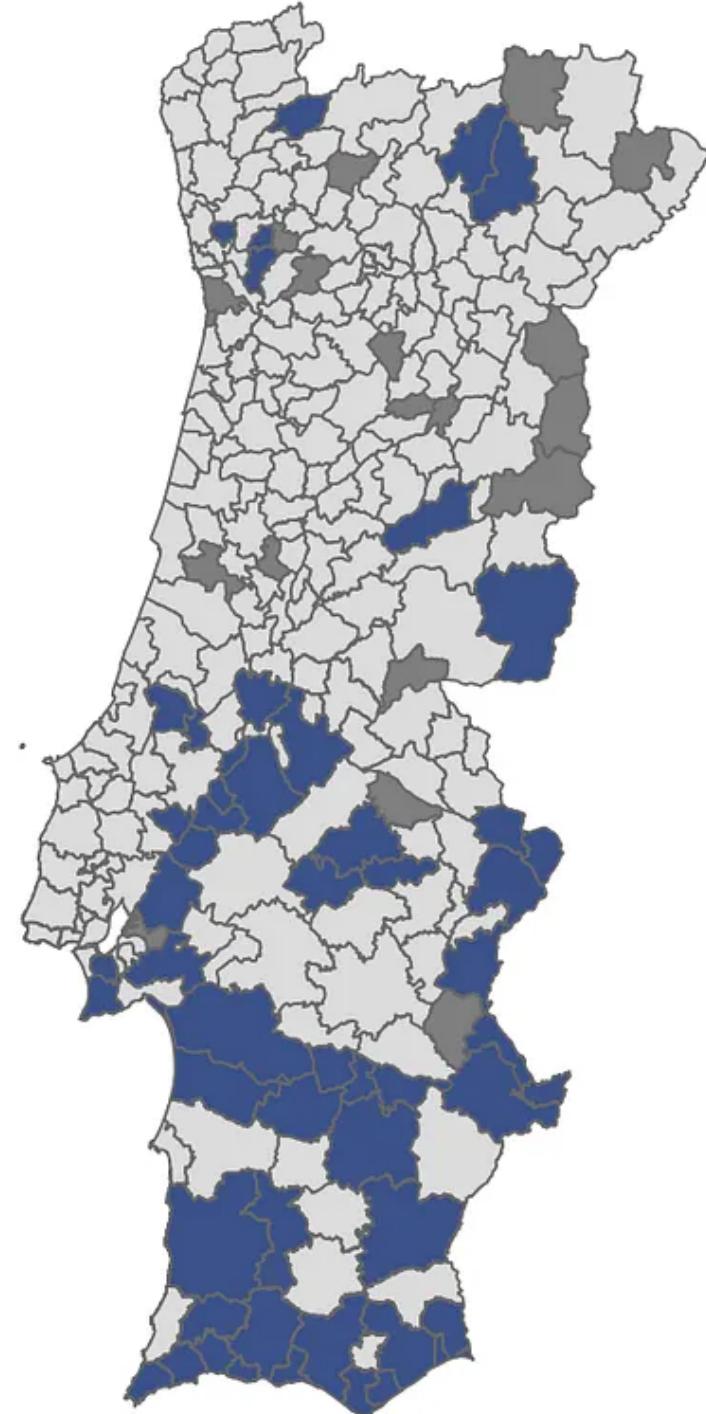


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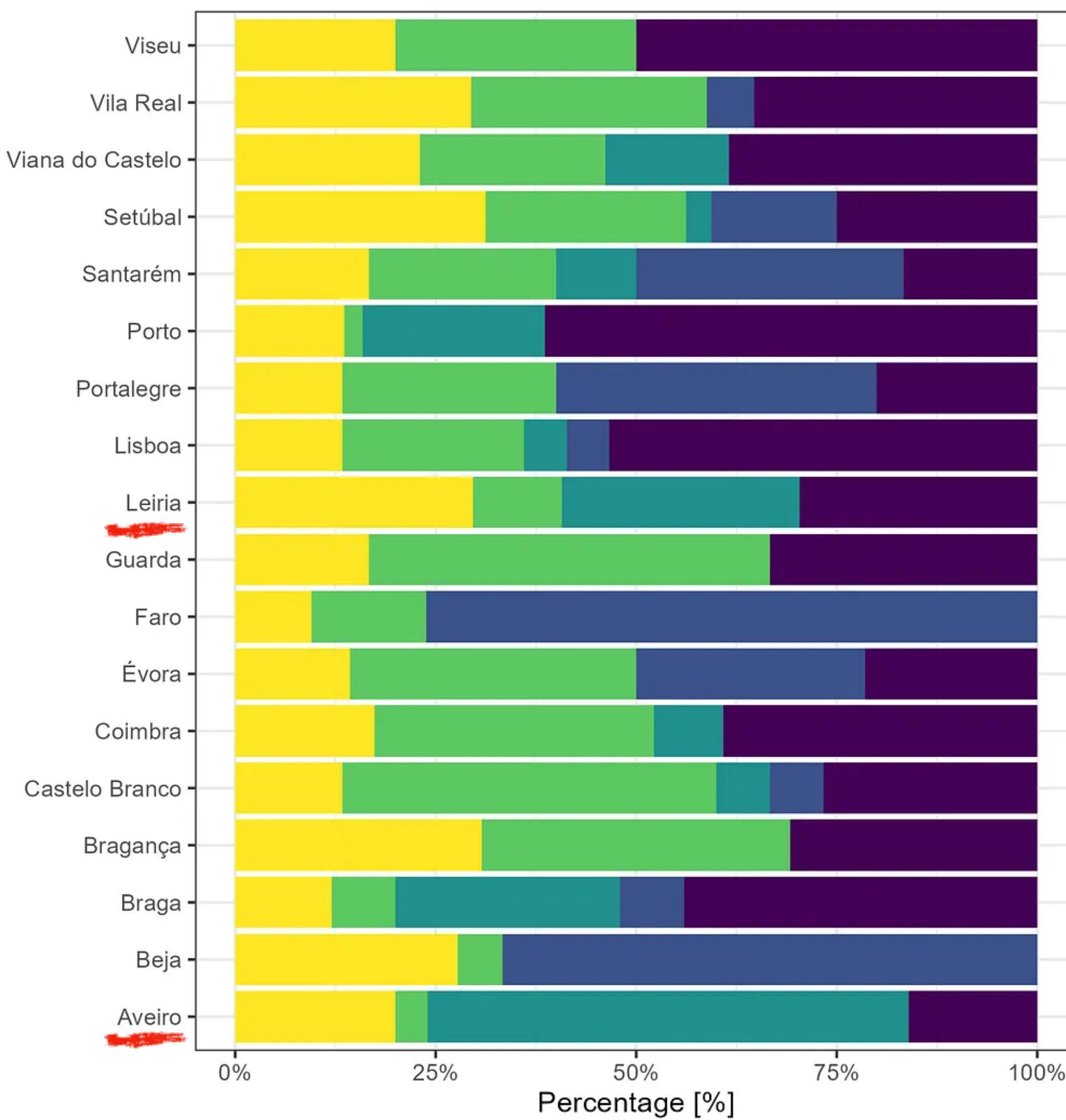
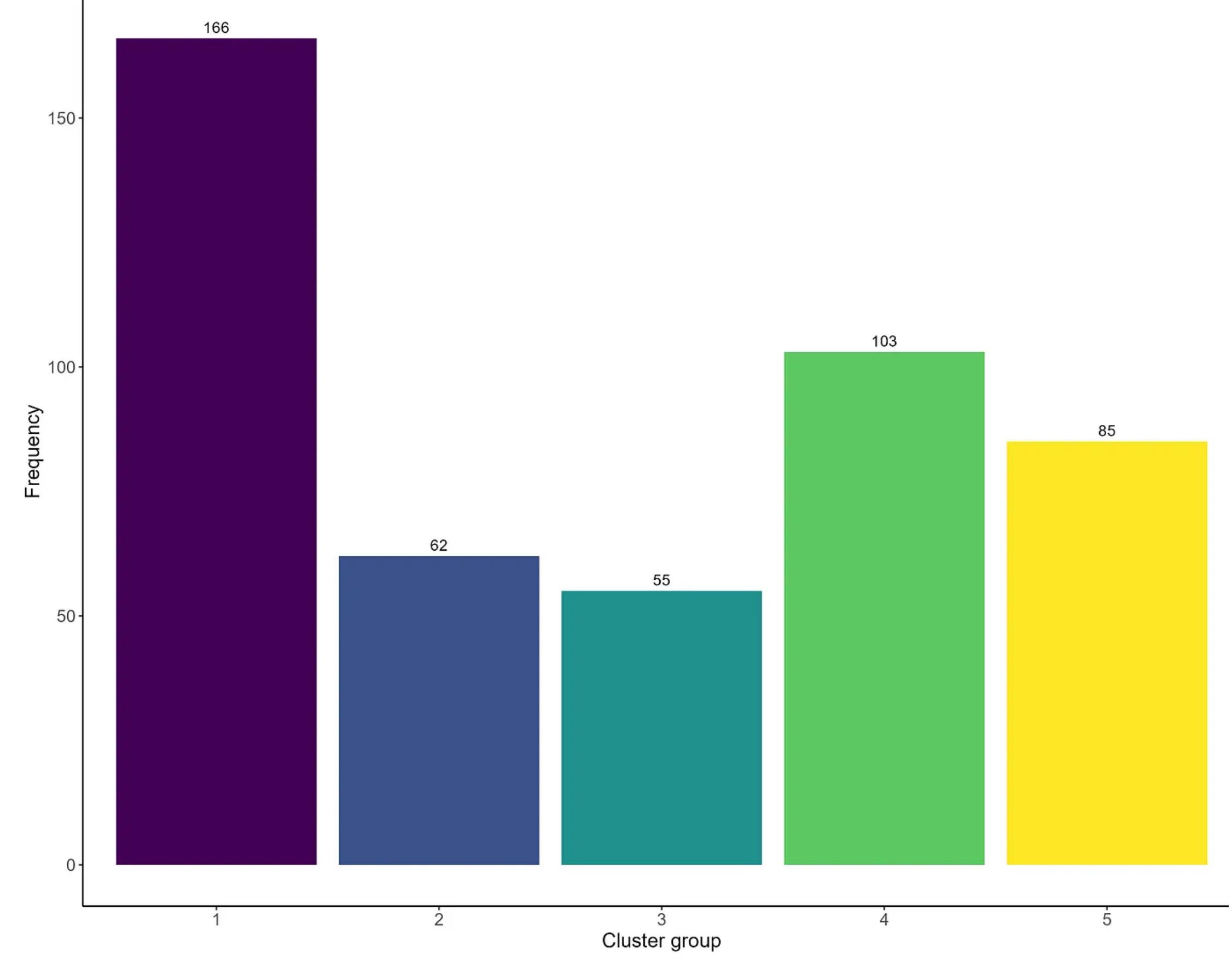
Resultados



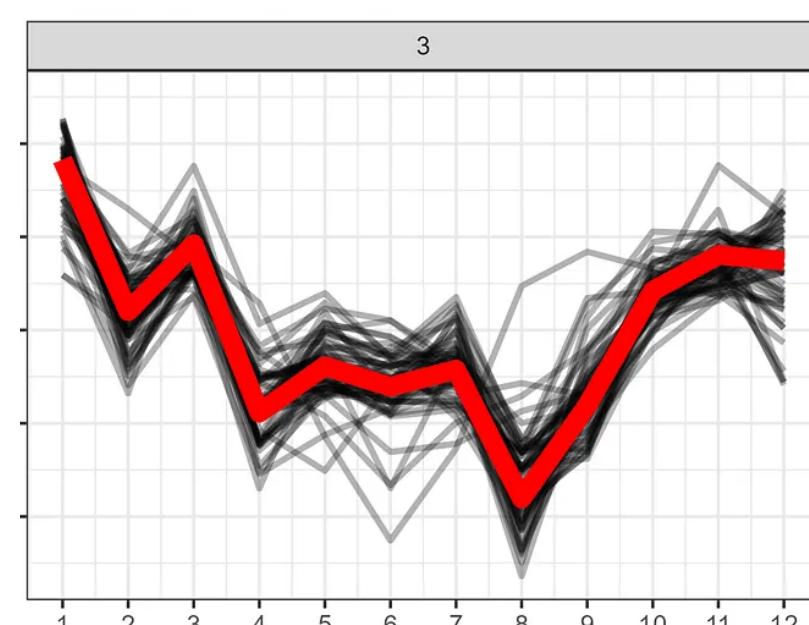
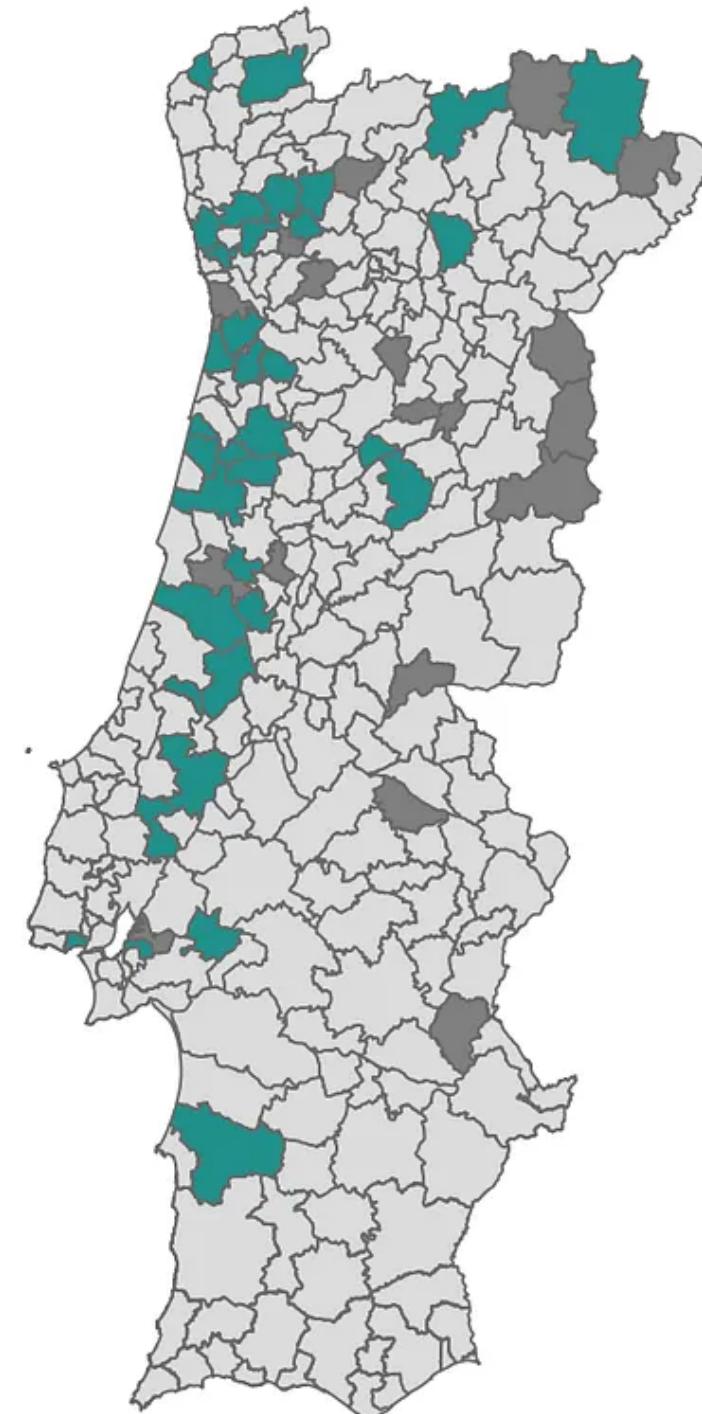
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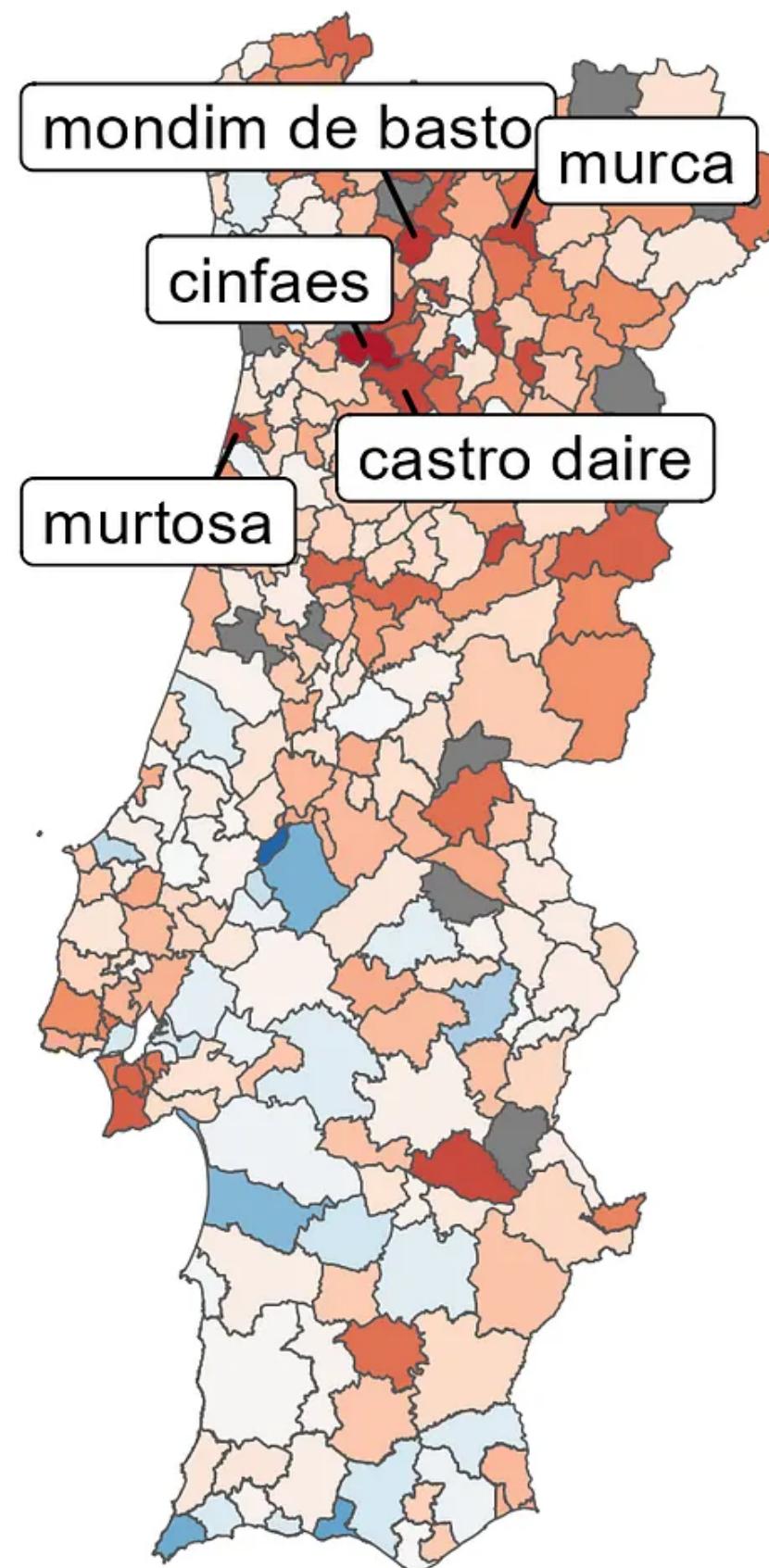


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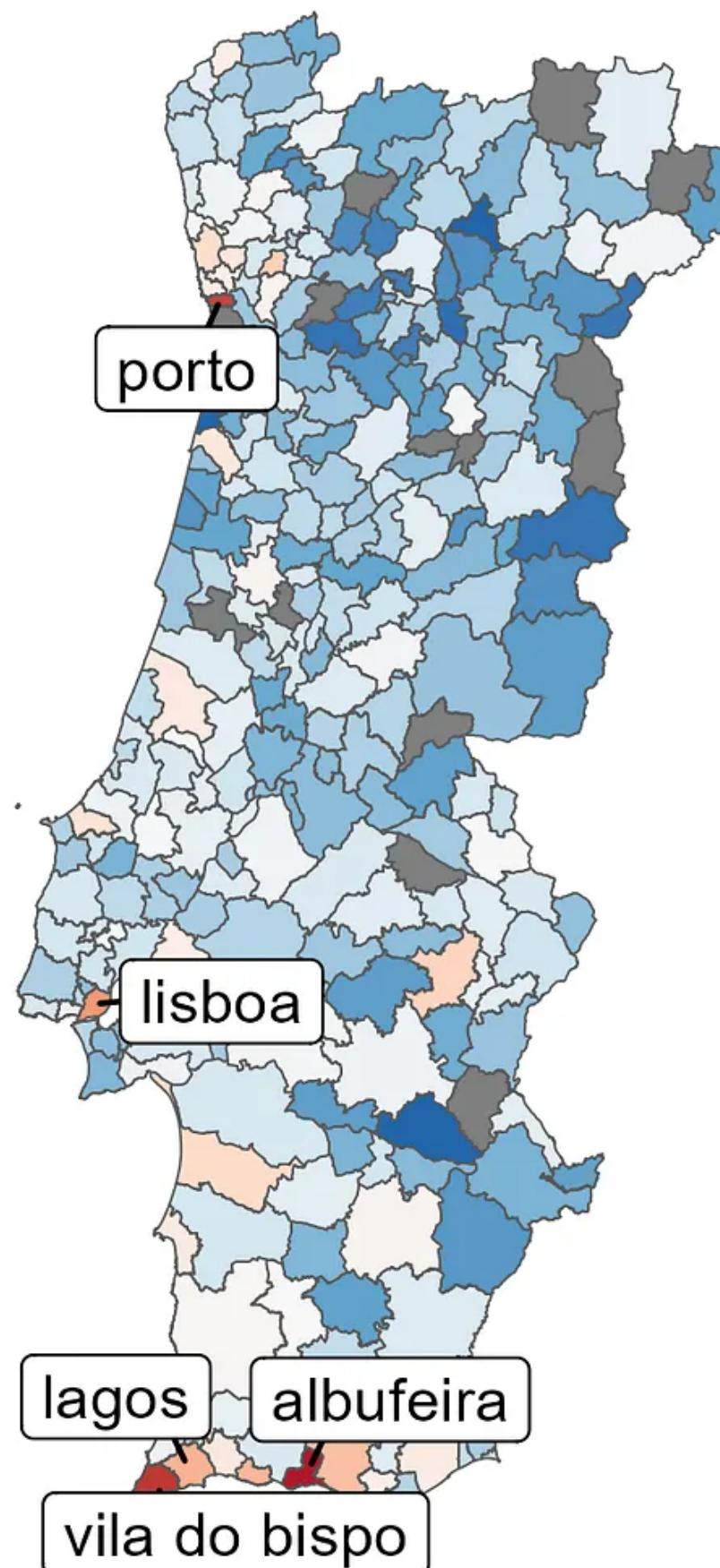


Resultados

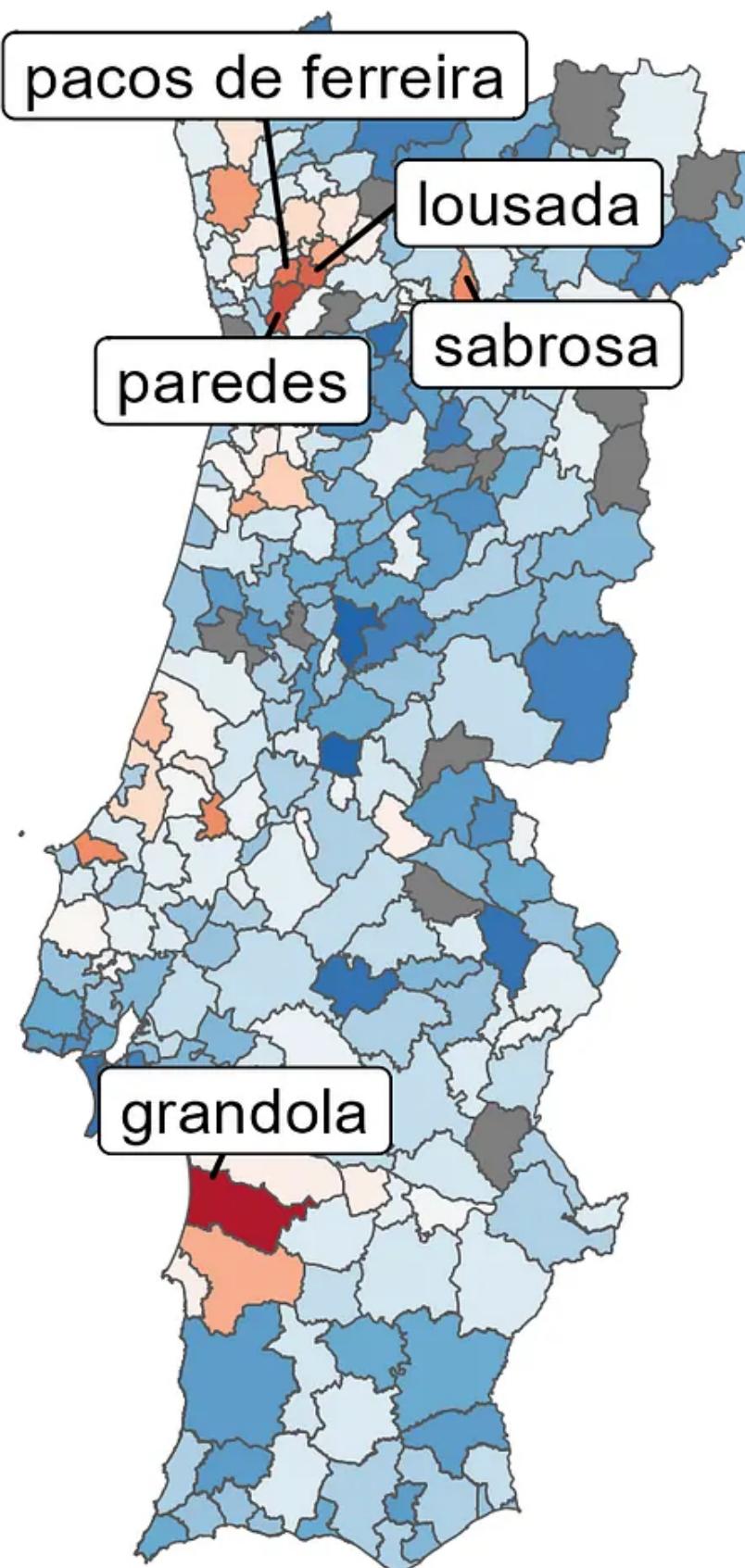
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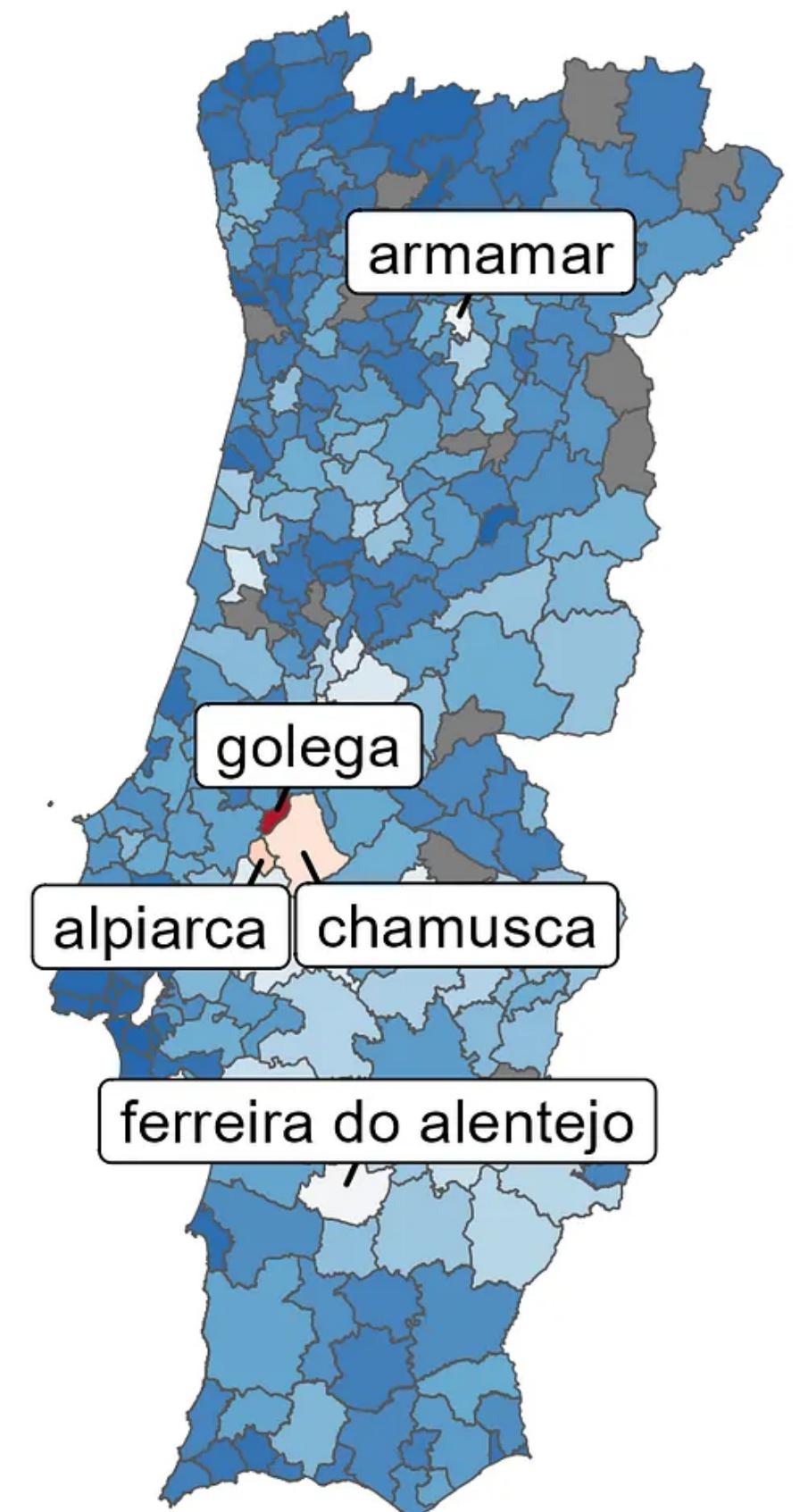
Not domestic



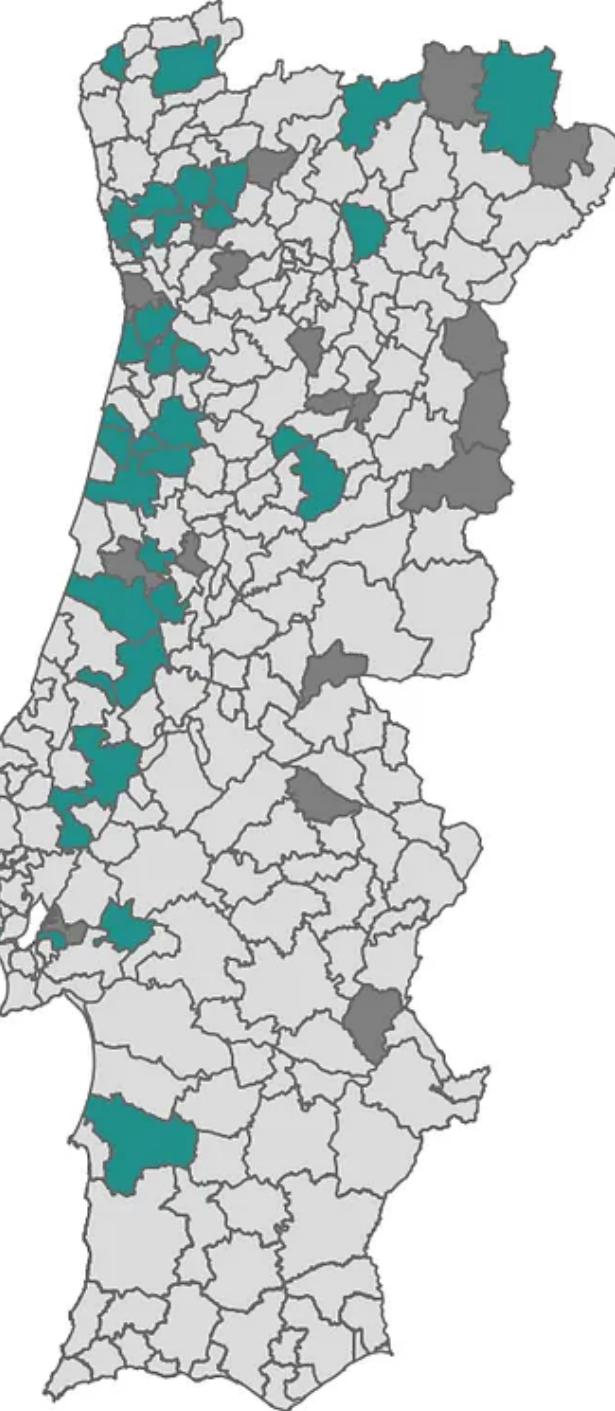
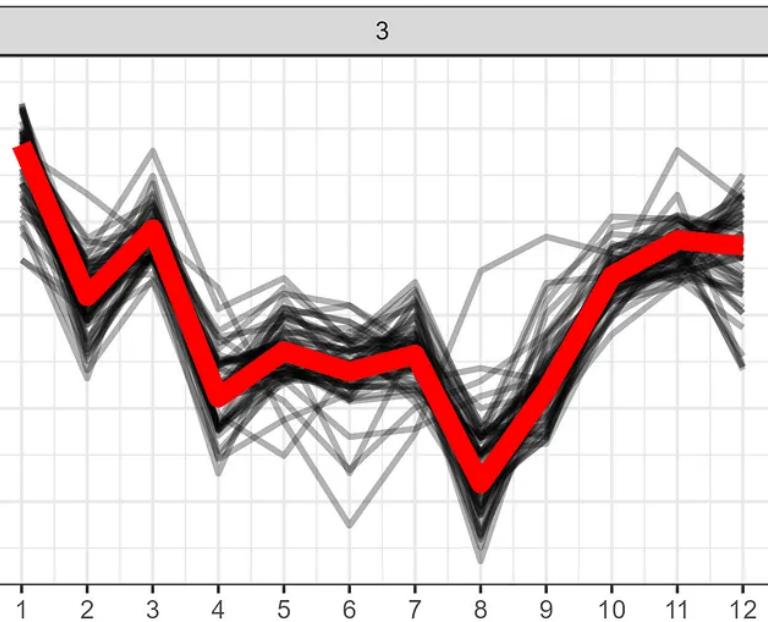
Industry



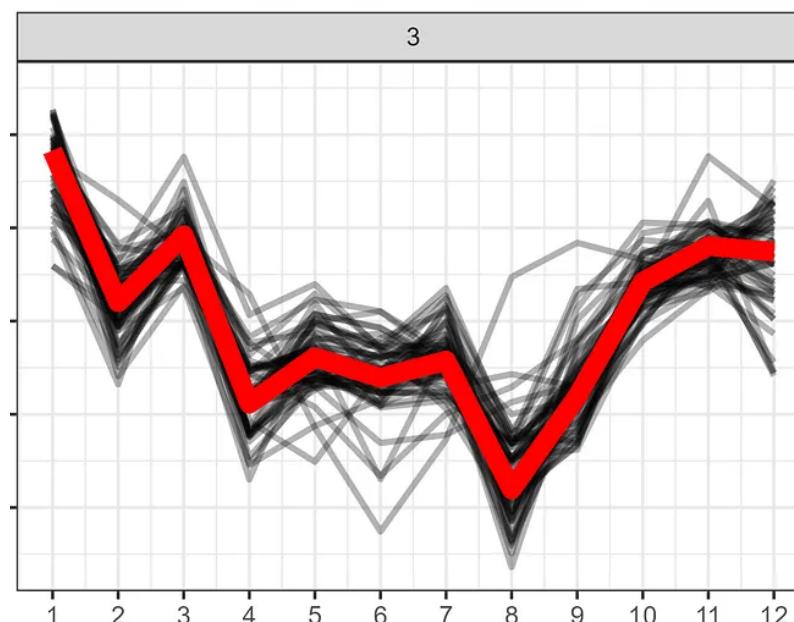
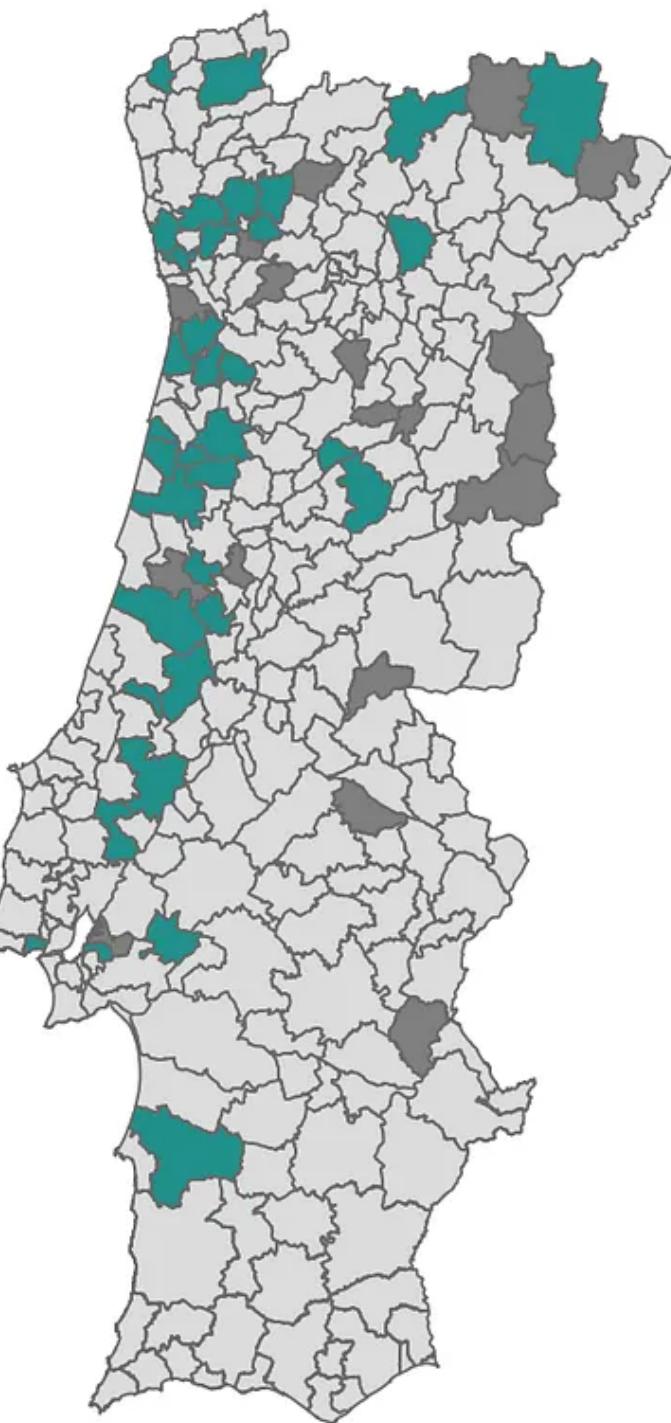
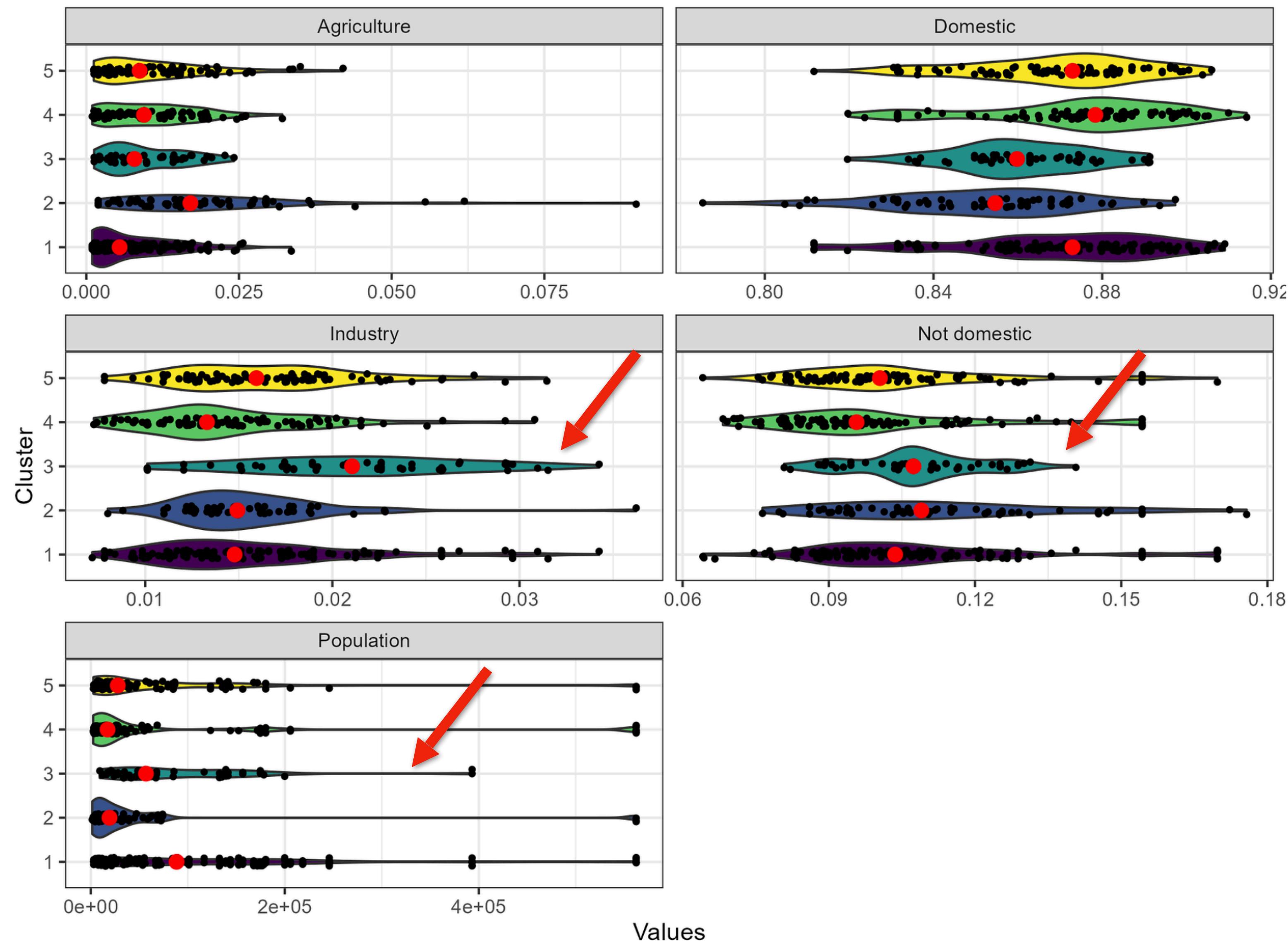
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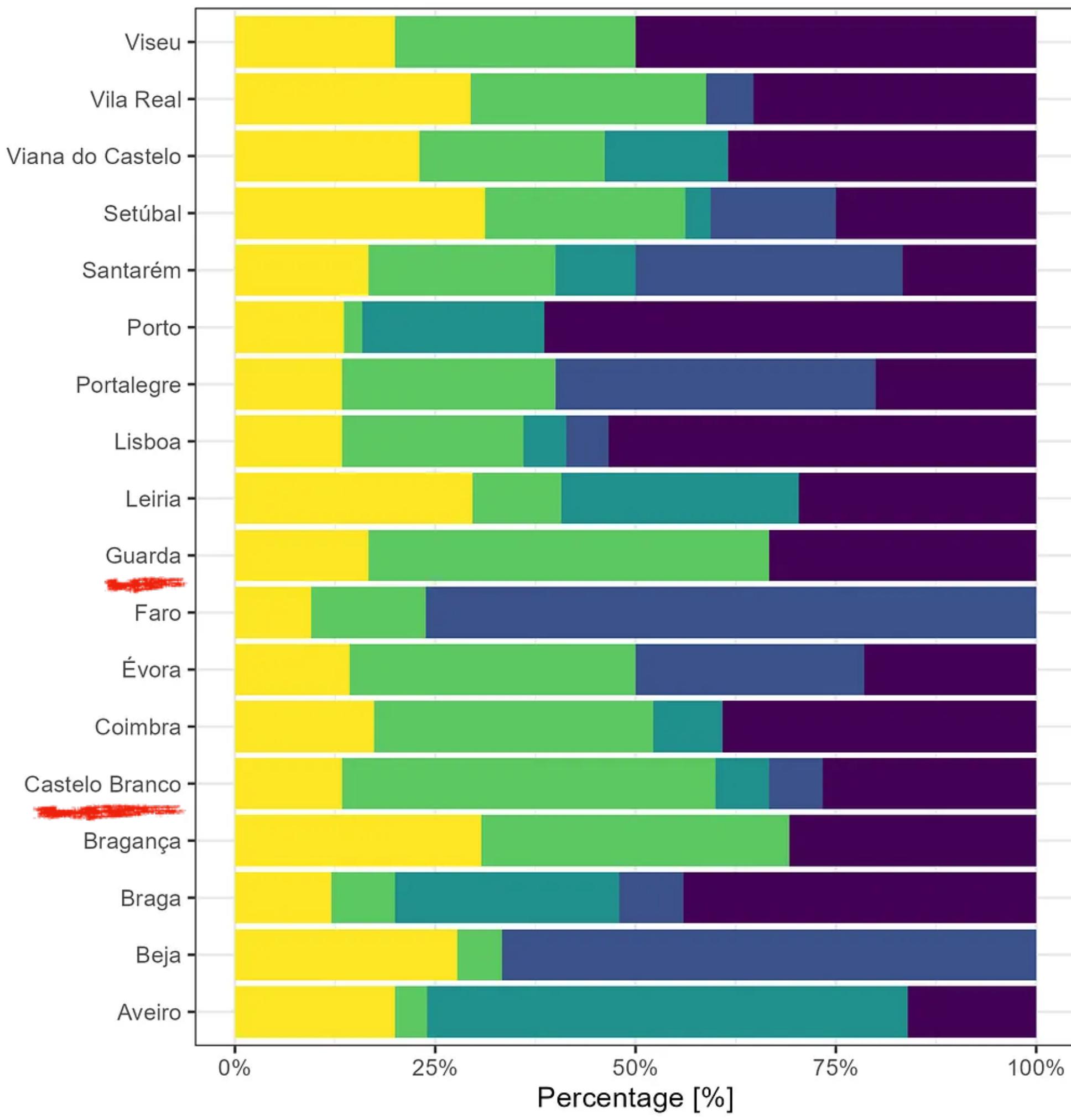
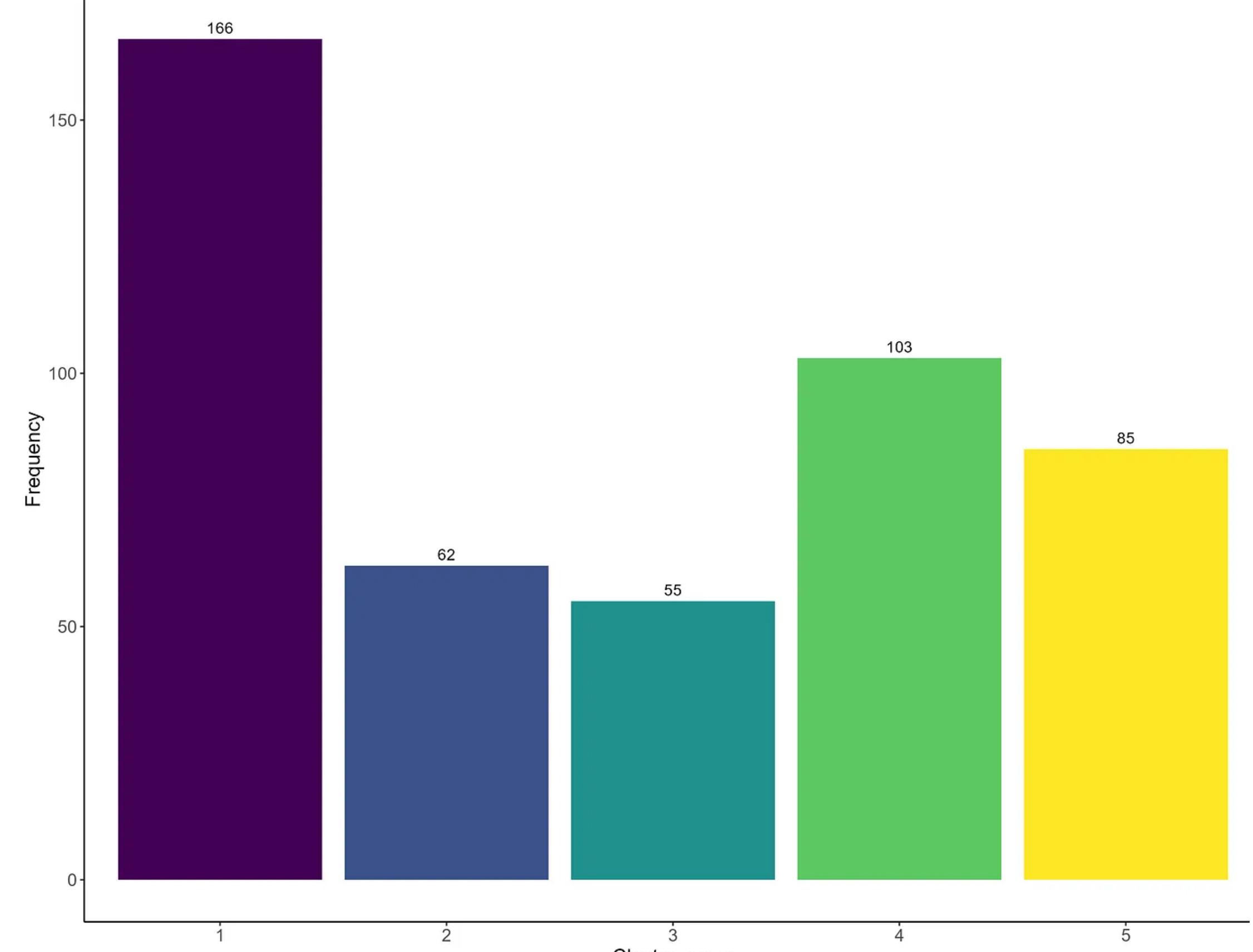


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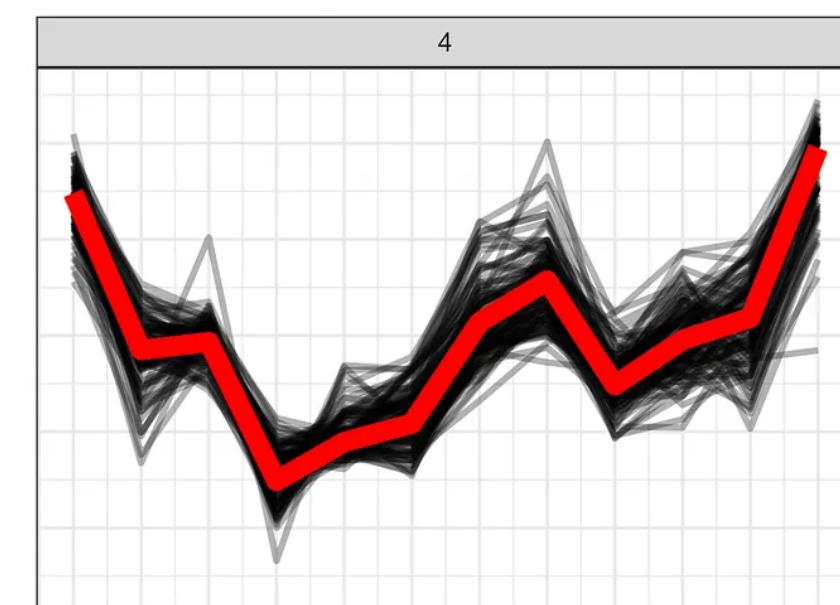
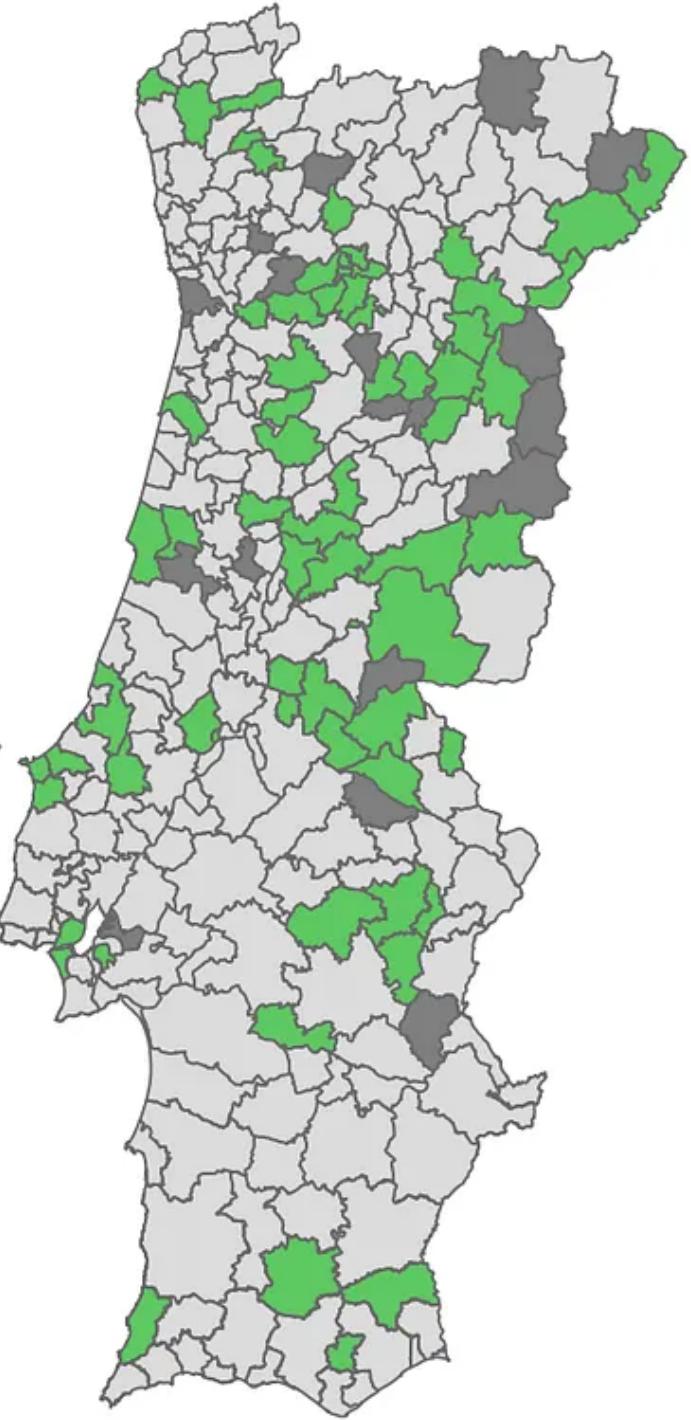


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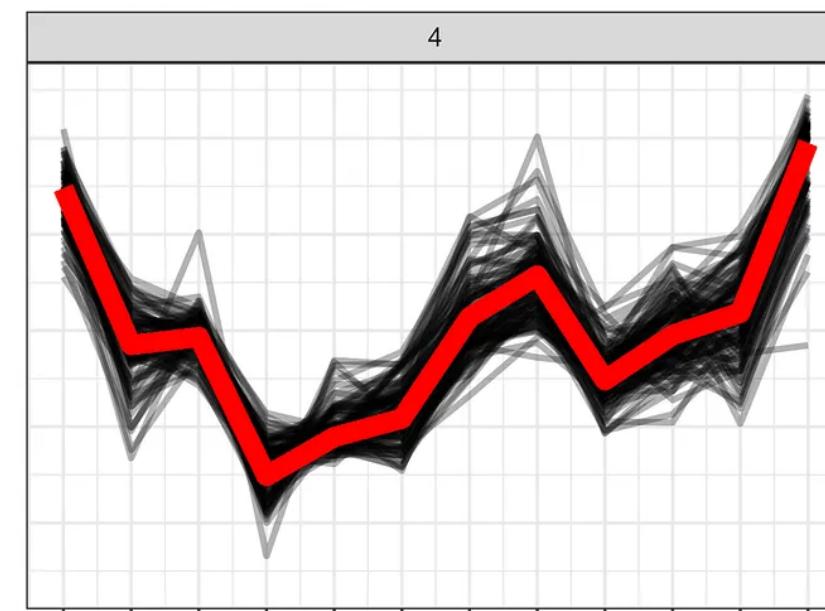
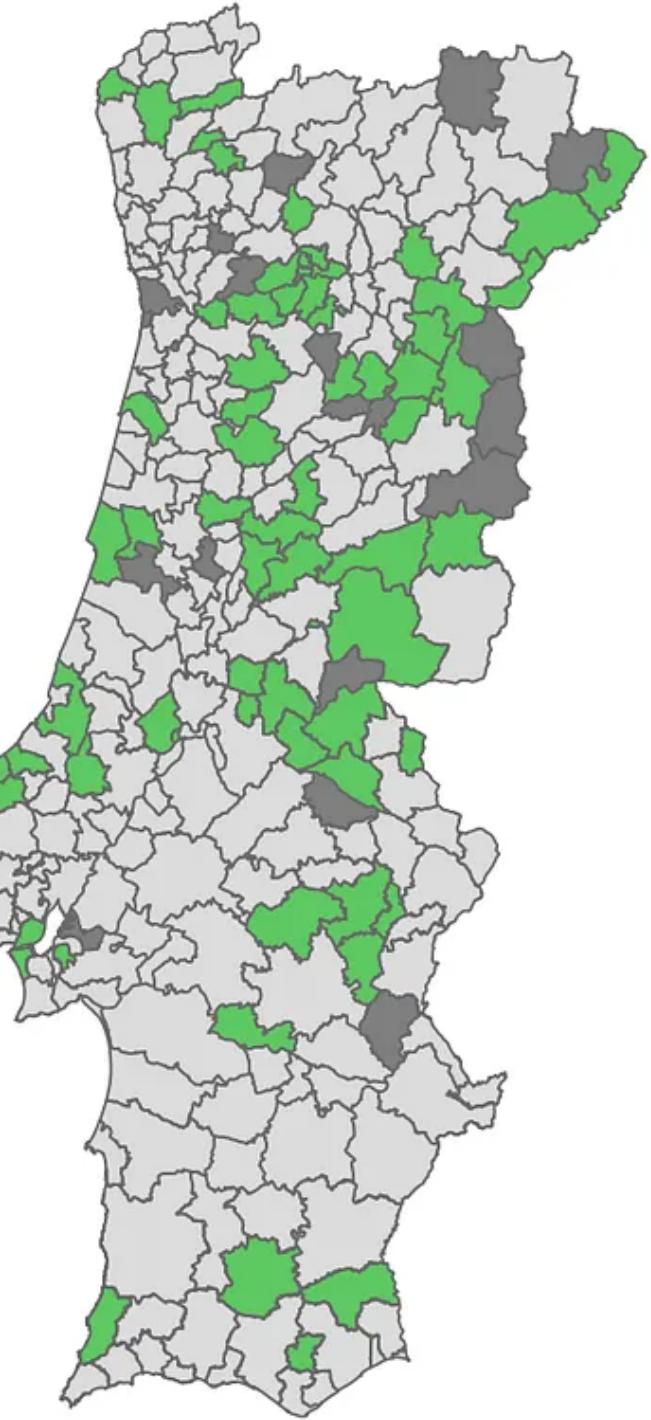
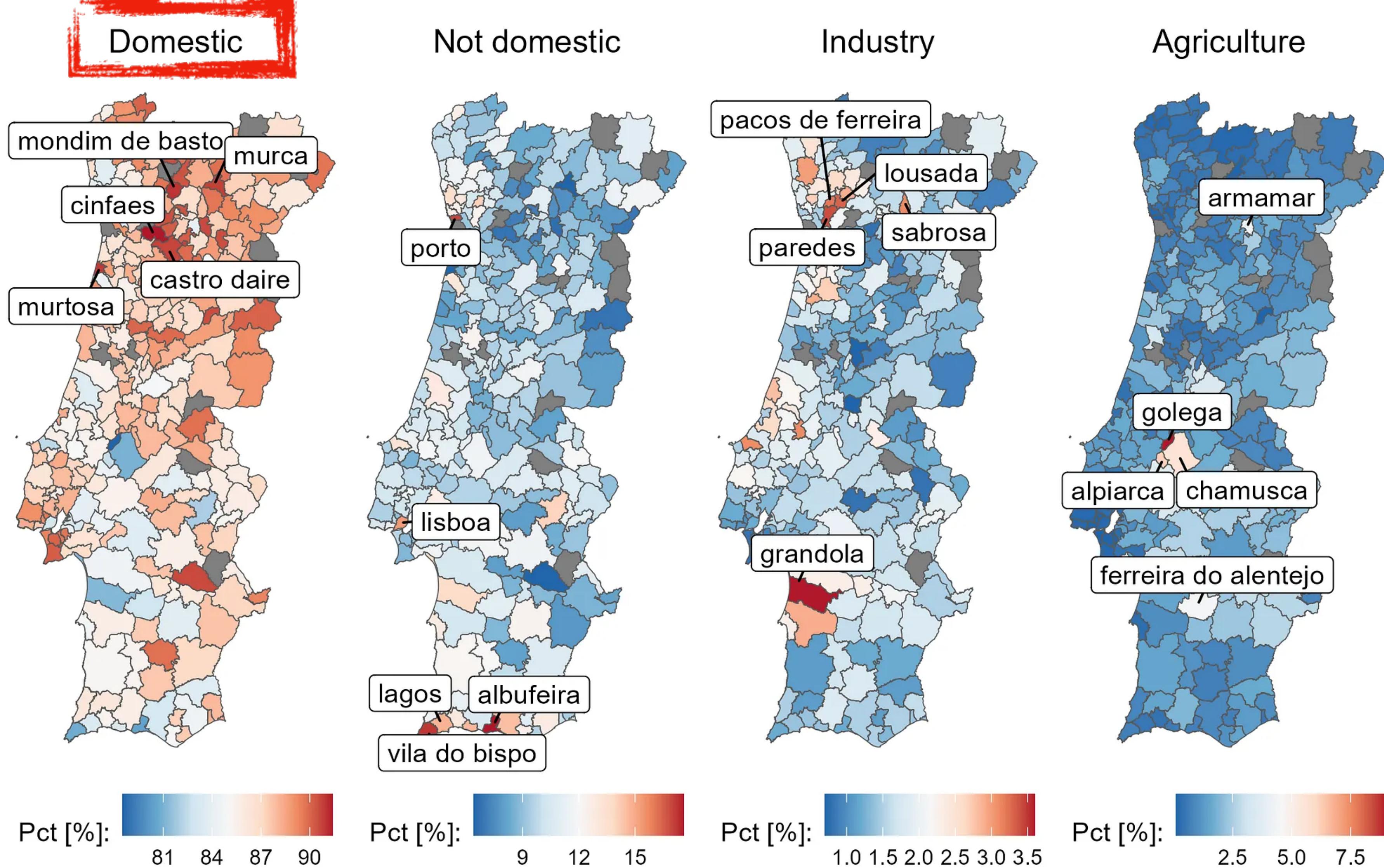
Resultados



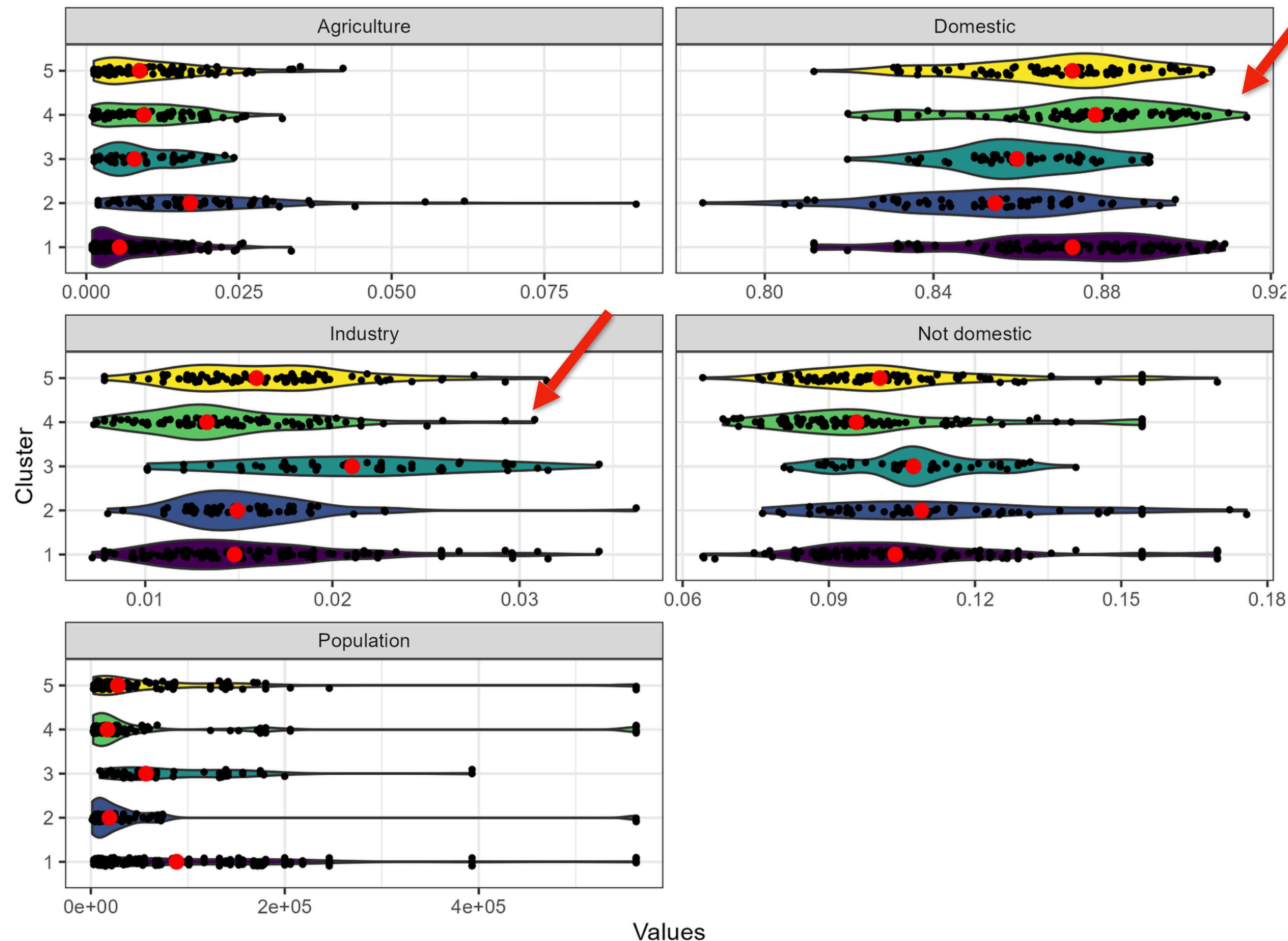
103 códigos



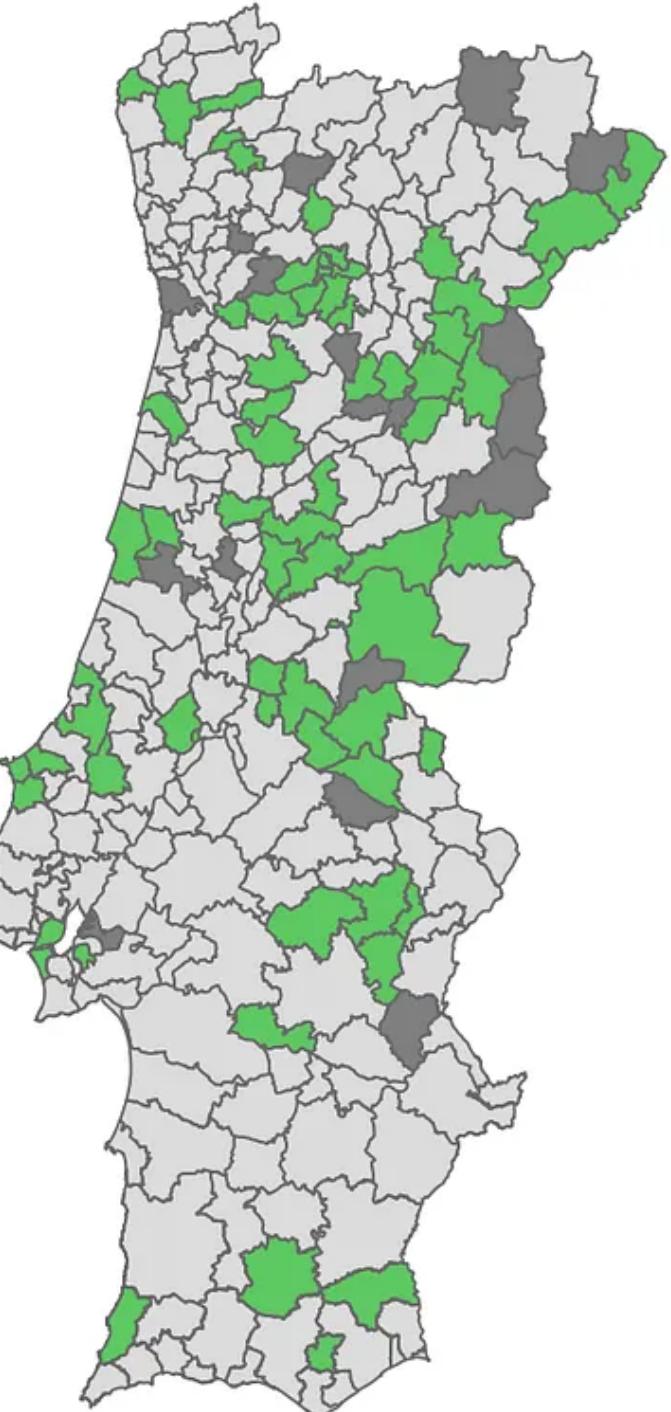
Resultados



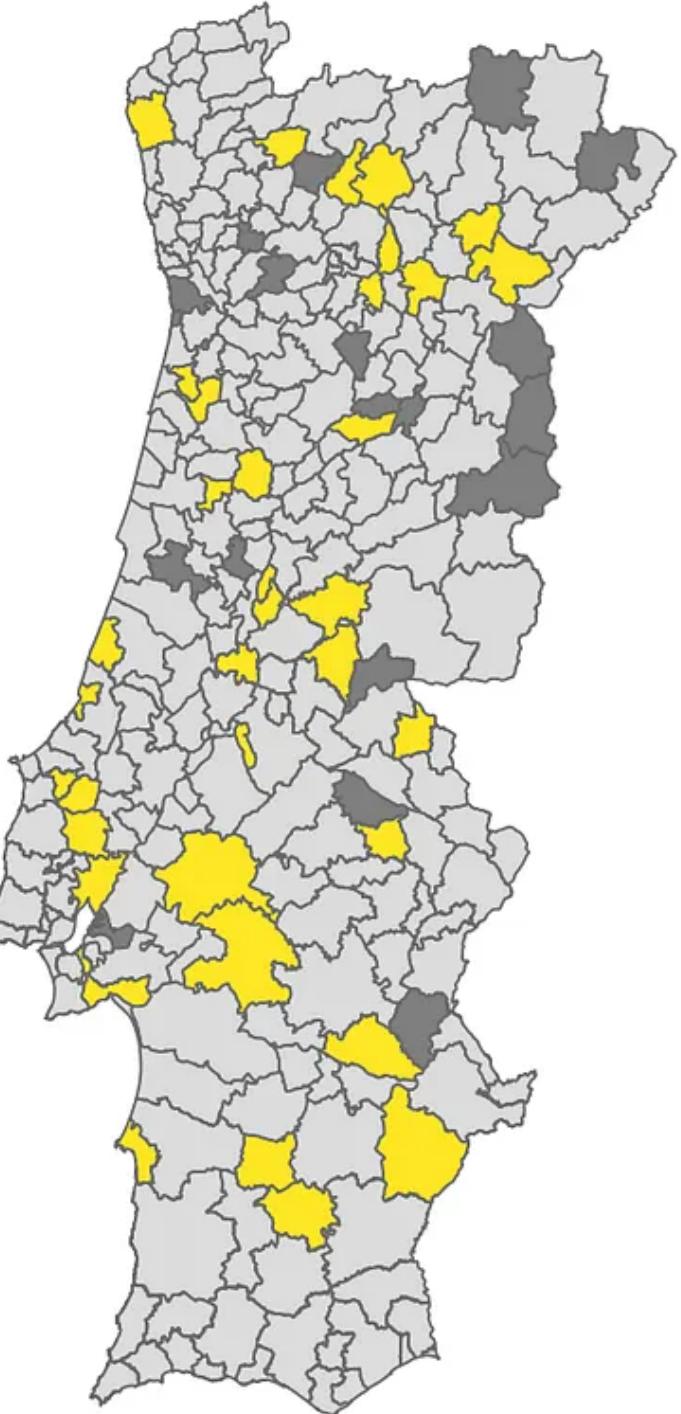
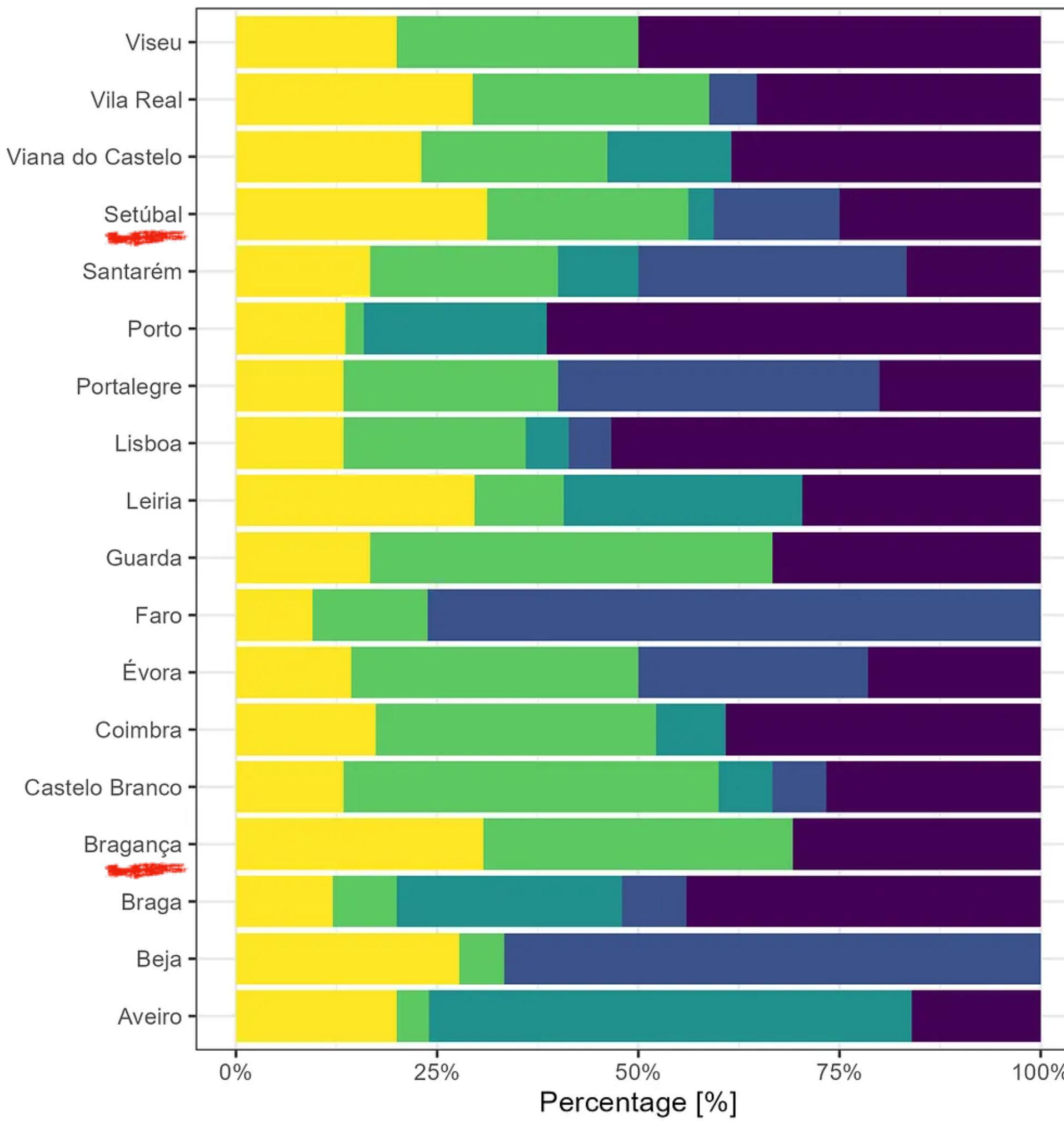
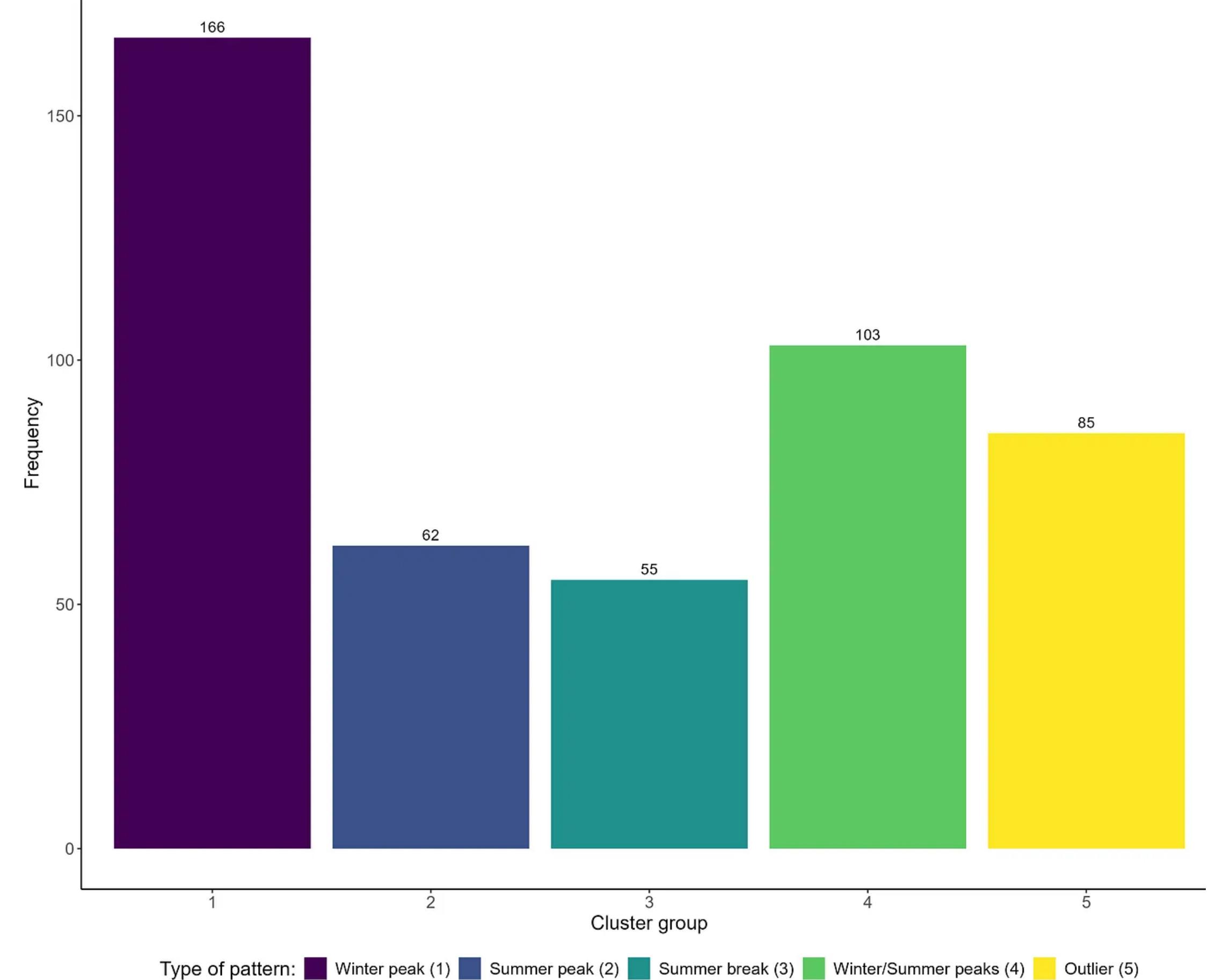
Resultados



103 códigos



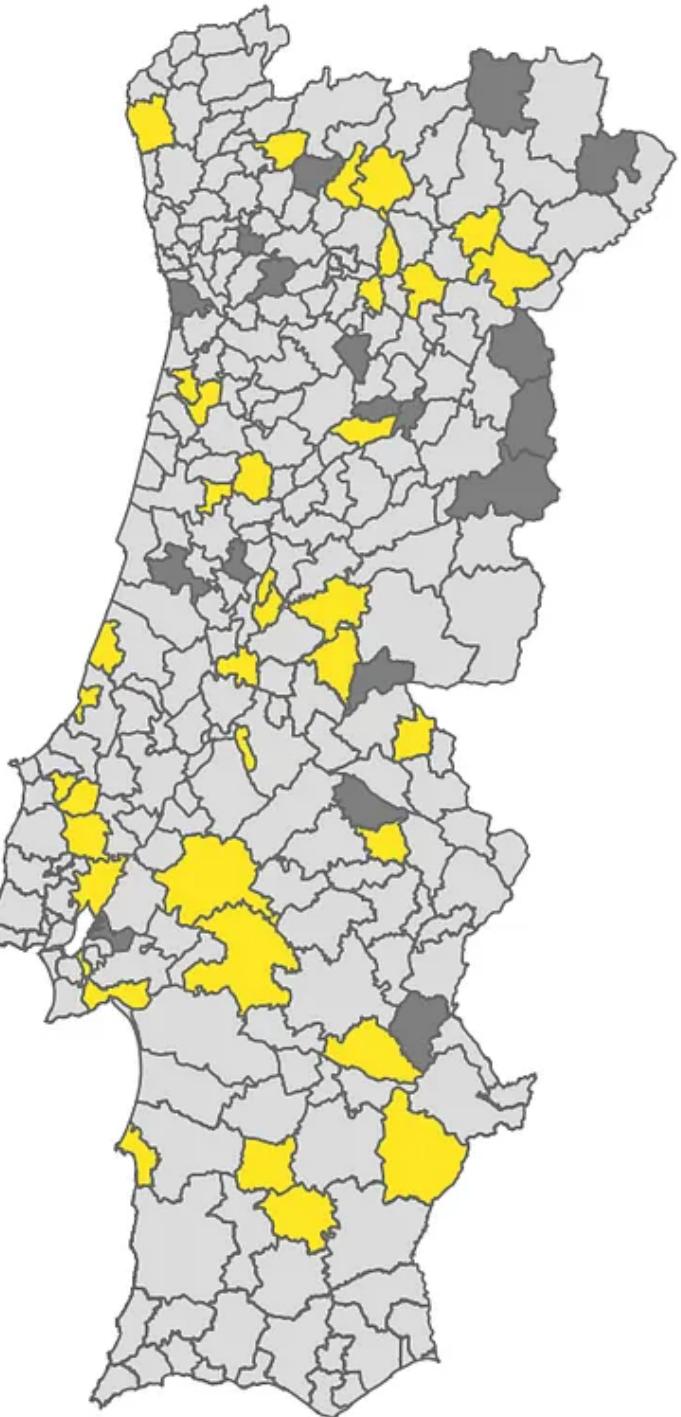
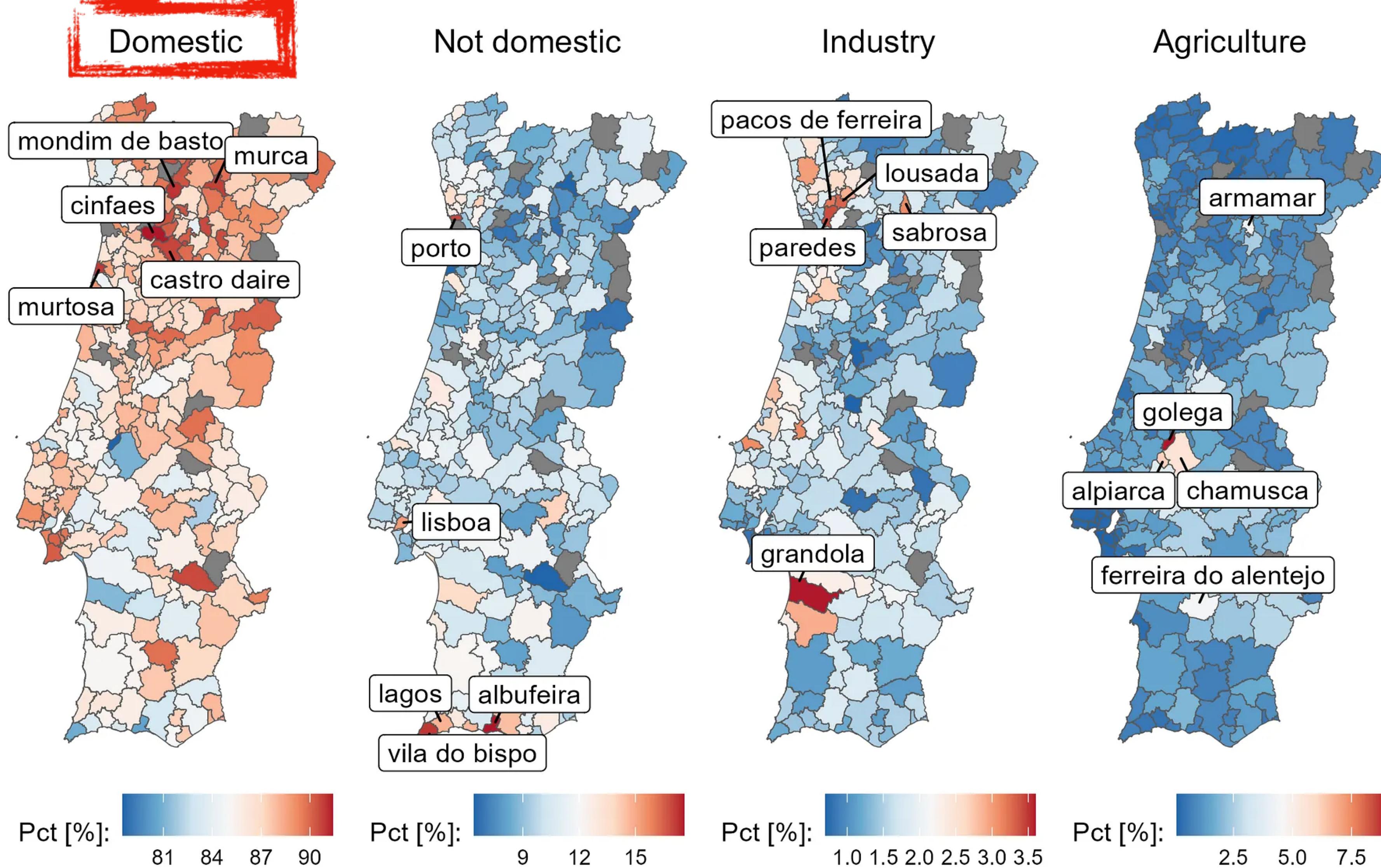
Resultados



**Valores Atípicos
(Outliers)**

85 códigos

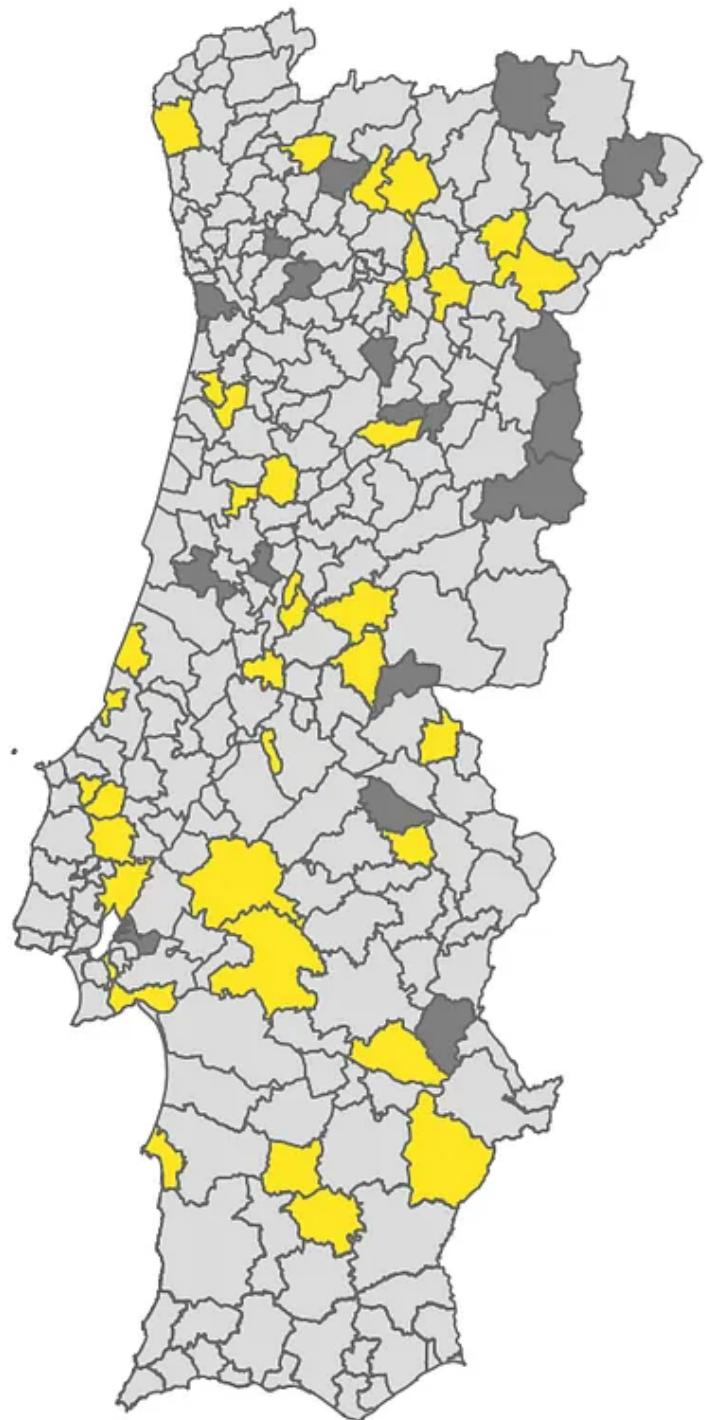
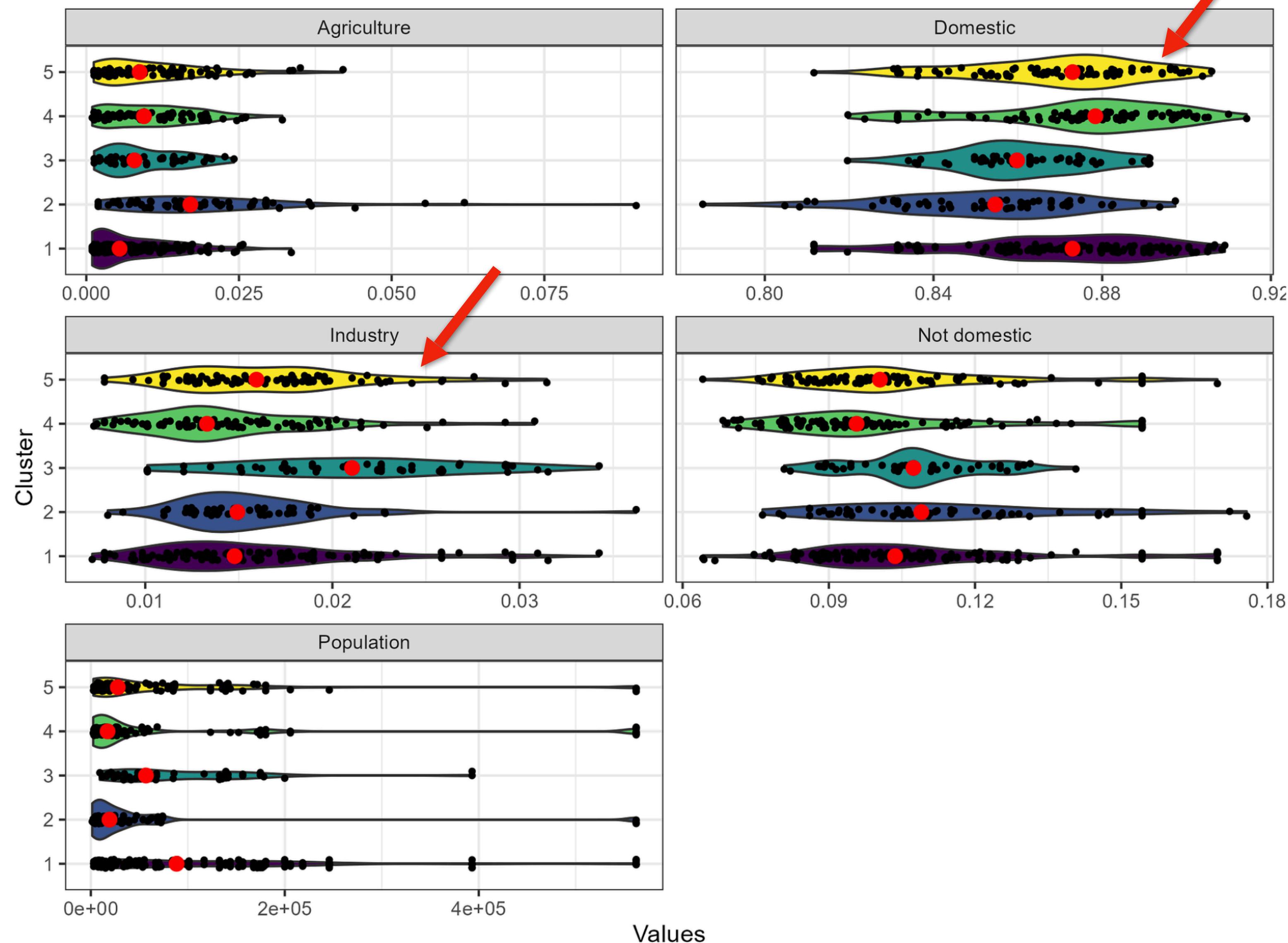
Resultados



**Valores Atípicos
(Outliers)**

85 códigos

Resultados



**Valores Atípicos
(Outliers)**

85 códigos

Conclusão

Cluster 1 – Pico no Inverno

- **Região:** Centro/Norte
- **Características:** Frio intenso; forte indústria; consumo estável; densidade populacional média/alta.

Cluster 2 – Pico no Verão

- **Região:** Sul
- **Características:** Altas temperaturas; agricultura predominante; turismo sazonal.

Cluster 3 – Quebra no Verão

- **Região:** Litoral (Centro/Norte)
- **Caraterísticas:** Mais consumo no inverno; queda marcada no verão; saída de residentes nas férias / abrandamento do setor industrial.

Cluster 4 – Picos Inverno/Verão

Região: Interior

Caraterísticas: Baixa densidade populacional; pouca indústria/turismo; consumo equilibrado por aquecimento e arrefecimento.

Cluster 5 – Outliers

- Concelhos com perfis atípicos ligados a atividades económicas (indústrias) específicas ou padrões irregulares.



Conclusão

Estudo revela padrões espaciais e sazonais úteis para políticas energéticas e planeamento urbano.

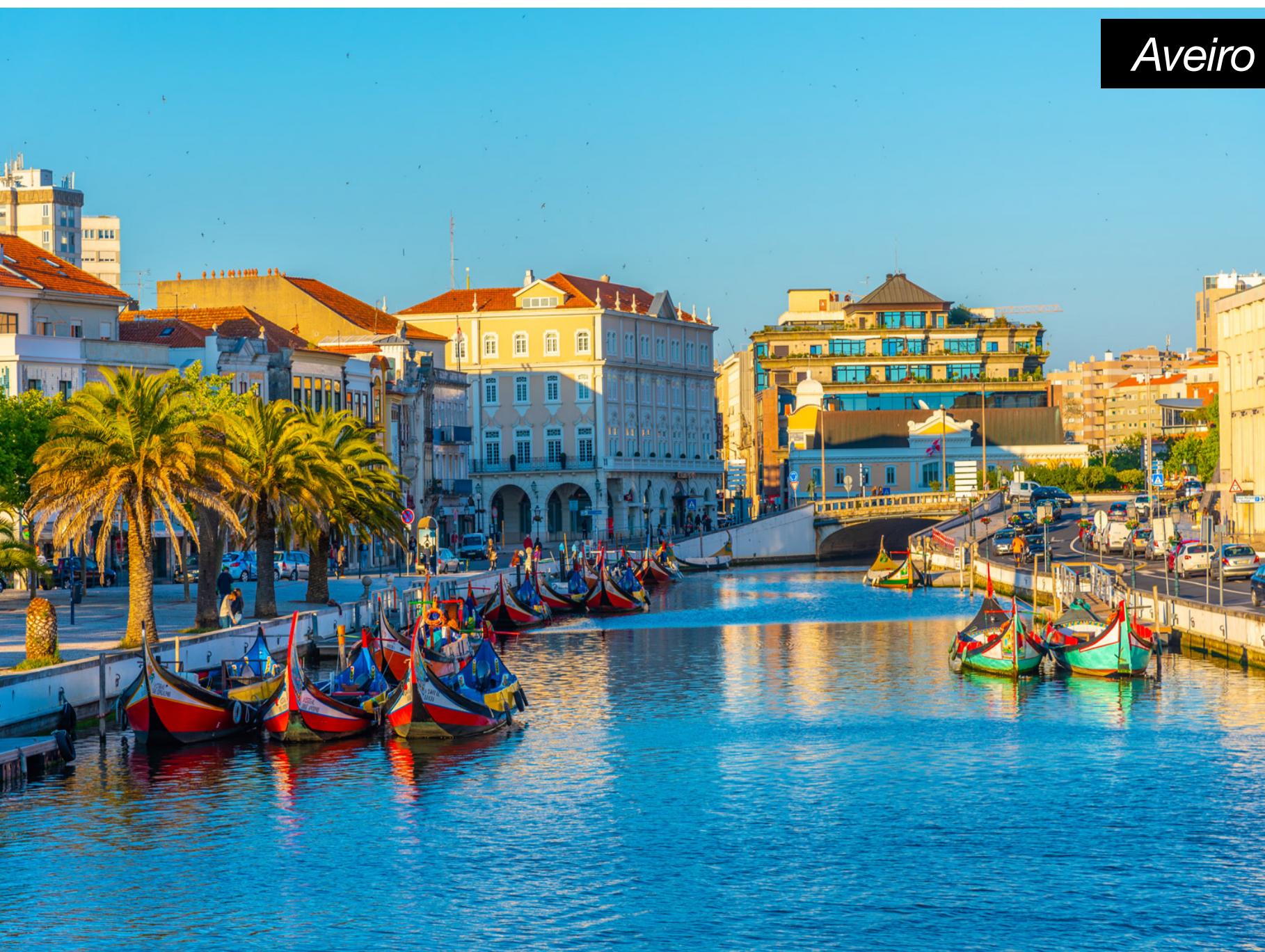
Resultados ajudam a adaptar estratégias regionais de gestão da procura e eficiência energética.

Futuras melhorias:

- **Dados temporais mais detalhados (horários/diários).**
- **Inclusão de mais fatores socioeconómicos e de eficiência energética.**
- **Uso de machine learning para previsão (forecasting) e apoio à gestão da procura.**



Aveiro





Castelo Branco



Viseu

Obrigado

Referências

Artigo: <https://medium.com/@DanLeiria/from-watts-to-clusters-portugals-electricity-usage-unveiled-2f080e64afd2>

Fotografias:

1. Porto: <https://unsplash.com/photos/brown-bridge-with-light-g3O3xWspoN4>
2. Lisboa: <https://unsplash.com/photos/green-grass-field-during-daytime-kgZXBMlt1cM>
3. Coimbra: <https://www.google.com/url?sa=i&url=https://www.idealista.pt/en/news/lifestyle-in-portugal/2024/06/17/60960-living-in-coimbra-portugal-a-city-of-charm-history-and-tradition&psig=AOvVaw3flpVbC08KRxJt2kM7M-5K&ust=1763760461306000&source=images&cd=vfe&opi=89978449&ved=0CBUQjRxqFwoTCODotvDvgZEDFQAAAAAdAAAAABAE>
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