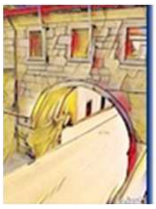

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UNIVERSIDADE BEIRA INTERIOR

Data analysis during Covid time
the e-invoice case

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Agenda

1. The Covid impact on response rates
2. Data collection during Covid: threat or opportunity?
3. Analysis and data treatment: Improving quality
4. Conclusions (learnings)

1. The Covid impact on response rates

- Response rates on **monthly** surveys
  (similar behaviour in the annual surveys)

Monthly Surveys	Response rates (%)				
	2019	2020			
		March	April	May	June
INTRASTAT	**80,5**	73,1	75,4	75,5	77,9
Qualitative - Trade	**93,5**	89,7	85,2	80,4	87,4
Qualitative - Industry	**92,5**	88,2	81,1	75,3	83,4
Qualitative - Services	**92,5**	89,5	83,5	79,3	86,0
Short-Term business Statistics - Trade	**79,0**	77,0	72,0	73,0	77,0
Short-Term business Statistics - Industry	**84,0**	80,0	80,0	81,0	82,0
Short-Term business Statistics - Services	**85,0**	83,0	82,0	82,0	83,0
Index Prices on products	**88,0**	77,0	81,0	78,0	81,0

1. The Covid impact on response rates

- It was not a surprise but simply **a fact we have to deal with**:

  The COVID-19 pandemic decreased the response rates to business surveys, particularly during the second quarter of 2020.

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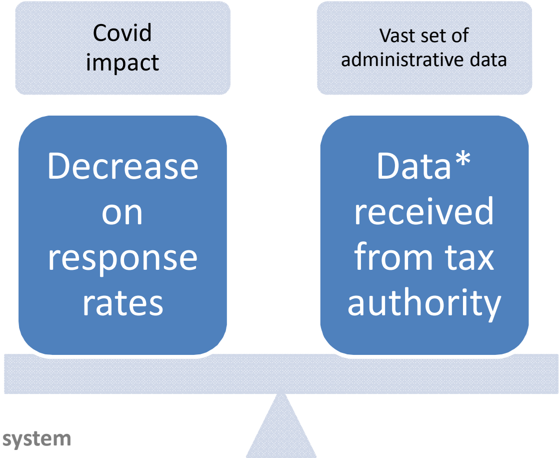
2. Data collection during Covid: threat or opportunity?

Two situations on the beginning of 2020:



Covid impact

Vast set of administrative data

Decrease on response rates

Data* received from tax authority

* Data from the e-invoice system

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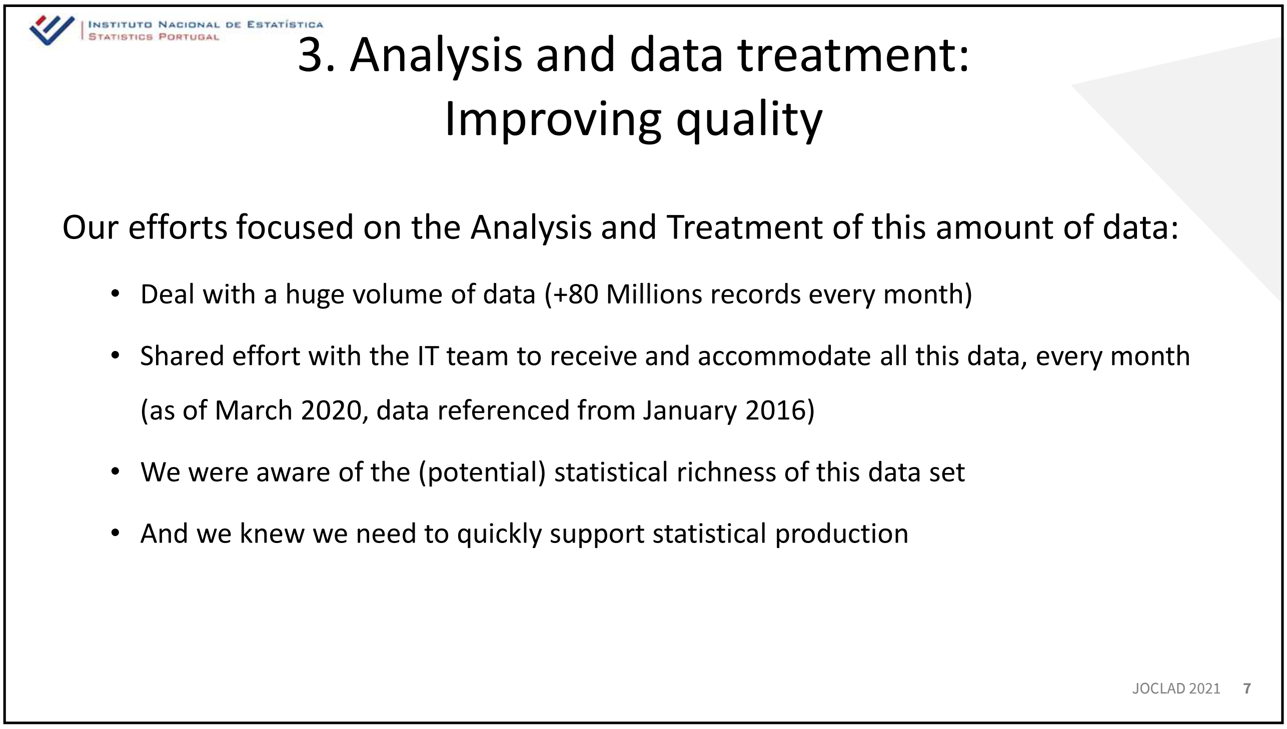
2. Data collection during Covid: threat or opportunity?

- We had two options:
  (1) cross our fingers and hope everything was going to be back to normal or…
  (2) **use administrative data** more intensively!

- The decision was obvious…
  – In this context, the information from the e-invoice system became more relevant, filling in the missing answers to the STS and contributing to the consistency of the results obtained in the production of statistical indicators



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3. Analysis and data treatment: Improving quality

Our efforts focused on the Analysis and Treatment of this amount of data:

- Deal with a huge volume of data (+80 Millions records every month)
- Shared effort with the IT team to receive and accommodate all this data, every month (as of March 2020, data referenced from January 2016)
- We were aware of the (potential) statistical richness of this data set
- And we knew we need to quickly support statistical production

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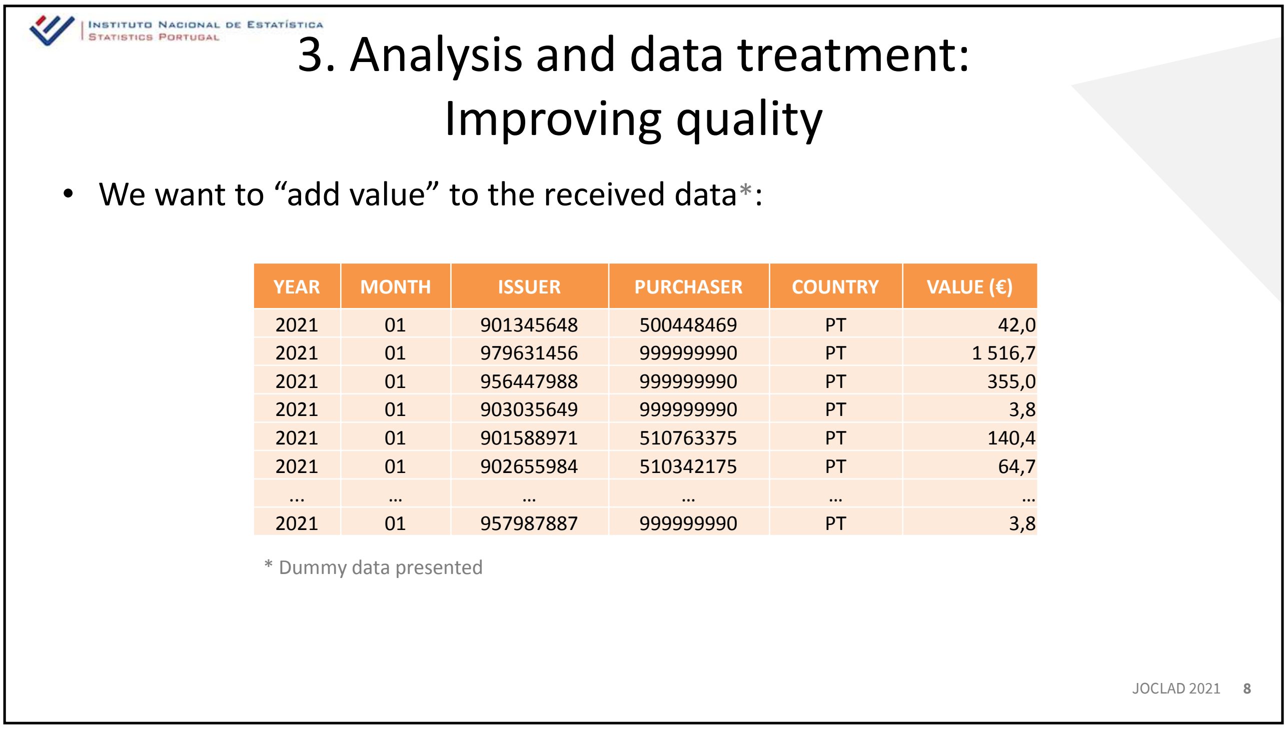

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3. Analysis and data treatment: Improving quality

- We want to "add value" to the received data*:

YEAR	MONTH	ISSUER	PURCHASER	COUNTRY	VALUE (€)
2021	01	901345648	500448469	PT	42,0
2021	01	979631456	999999990	PT	1 516,7
2021	01	956447988	999999990	PT	355,0
2021	01	903035649	999999990	PT	3,8
2021	01	901588971	510763375	PT	140,4
2021	01	902655984	510342175	PT	64,7
…	…	…	…	…	…
2021	01	957987887	999999990	PT	3,8

* Dummy data presented

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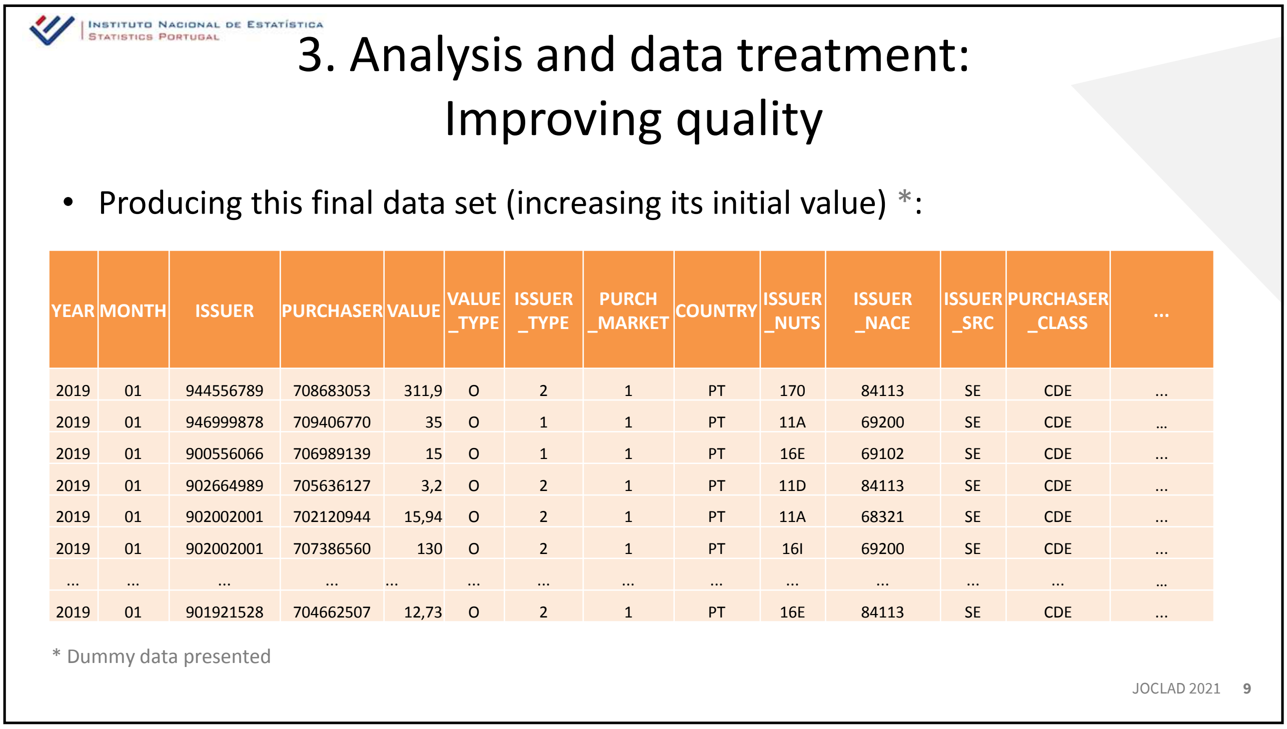
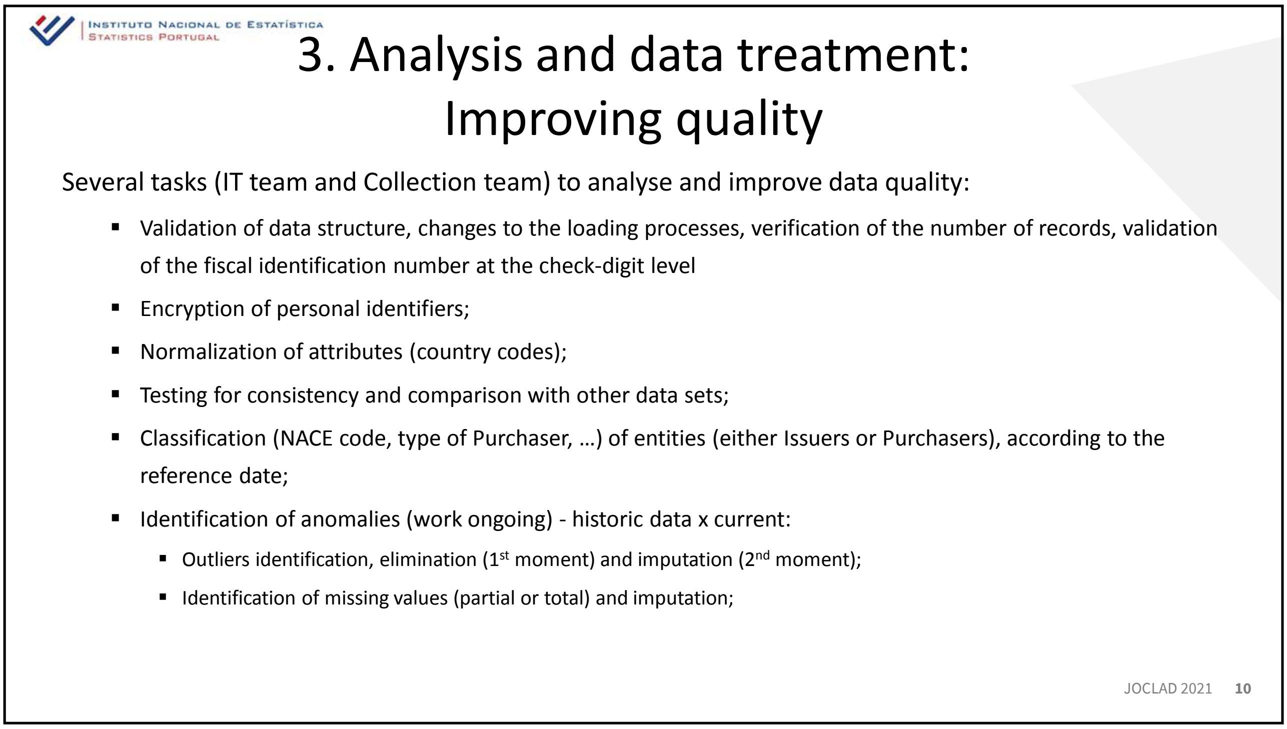


3. Analysis and data treatment: Improving quality

- Producing this final data set (increasing its initial value) *:

YEAR	MONTH	ISSUER	PURCHASER	VALUE	VALUE_TYPE	ISSUER_TYPE	PURCH_MARKET	COUNTRY	ISSUER_NUTS	ISSUER_NACE	ISSUER_SRC	PURCHASER_CLASS	…
2019	01	944556789	708683053	311,9	O	2	1	PT	170	84113	SE	CDE	…
2019	01	946999878	709406770	35	O	1	1	PT	11A	69200	SE	CDE	…
2019	01	900556066	706989139	15	O	1	1	PT	16E	69102	SE	CDE	…
2019	01	902664989	705636127	3,2	O	2	1	PT	11D	84113	SE	CDE	…
2019	01	902002001	702120944	15,94	O	2	1	PT	11A	68321	SE	CDE	…
2019	01	902002001	707386560	130	O	2	1	PT	16I	69200	SE	CDE	…
…	…	…	…	…	…	…	…	…	…	…	…	…	…
2019	01	901921528	704662507	12,73	O	2	1	PT	16E	84113	SE	CDE	…

* Dummy data presented



3. Analysis and data treatment: Improving quality

Several tasks (IT team and Collection team) to analyse and improve data quality:

- Validation of data structure, changes to the loading processes, verification of the number of records, validation of the fiscal identification number at the check-digit level
- Encryption of personal identifiers;
- Normalization of attributes (country codes);
- Testing for consistency and comparison with other data sets;
- Classification (NACE code, type of Purchaser, …) of entities (either Issuers or Purchasers), according to the reference date;
- Identification of anomalies (work ongoing) - historic data x current:
    - Outliers identification, elimination (1st moment) and imputation (2nd moment);
    - Identification of missing values (partial or total) and imputation;

3. Analysis and data treatment: Improving quality

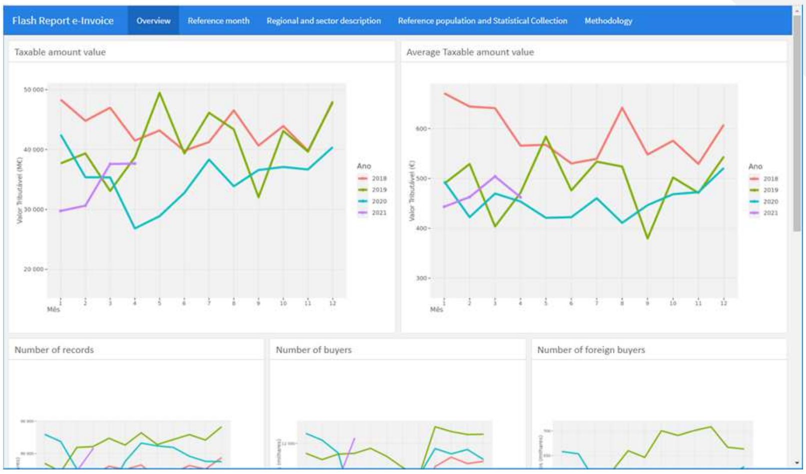
Importance of communicating with statistical users

- Handling administrative data for Statistical purposes should **not be seen as a one-way** communication process
- In order to promote the use of data, it is important to know the needs and expectations of its recipients in the statistical production process
- **A close dialogue with data users** was promoted in order to consider and harmonize their needs in the adoption of a data treatment that would be accepted by all
- To facilitate data analysis and exploration a monthly Flash report was developed in "R Flexdashboard"

3. Analysis and data treatment: Improving quality

Importance of communicating with statistical users

- Example of a Flash-report about e-invoice data produced and shared every month



3. Analysis and data treatment: Improving quality

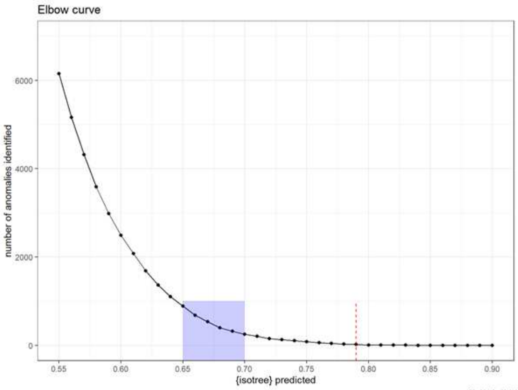
Outliers analysis (work in progress)

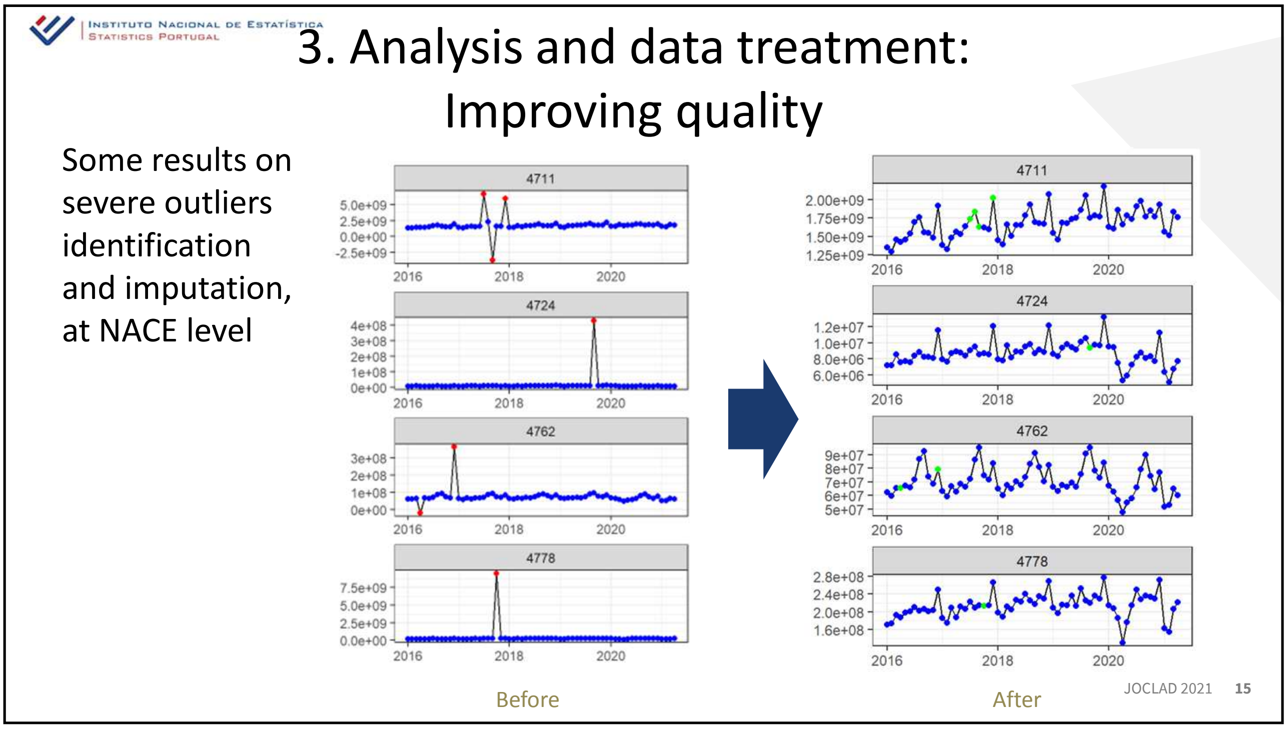
- Built 845 time-series (NACE level) for each issuer, grouping data by NACE and summing monthly total values.
- To each of these time-series applied the isolation forest algorithm (univariate analysis), in order to compute the probability of an observation being anomalous.
- Then, iteratively and using also Isolation Forest algorithm, search for anomalies at the issuer/buyer pair (pair level)
- Impute values when anomalies at pair level agree (on the same observation period) with those from NACE level (Kalman – Smoothing algorithm)

3. Analysis and data treatment: Improving quality

Outliers analysis (work in progress)

- To define a cut-off value for the probability of anomaly (isolation forest score), we use an elbow curve with the number of anomalies detected for different scores within each NACE.
- for the most severe anomalies we chose observations with a score > 0.79 at level NACE and score > 0.7 at level pair issuer / acquirer (buyer)





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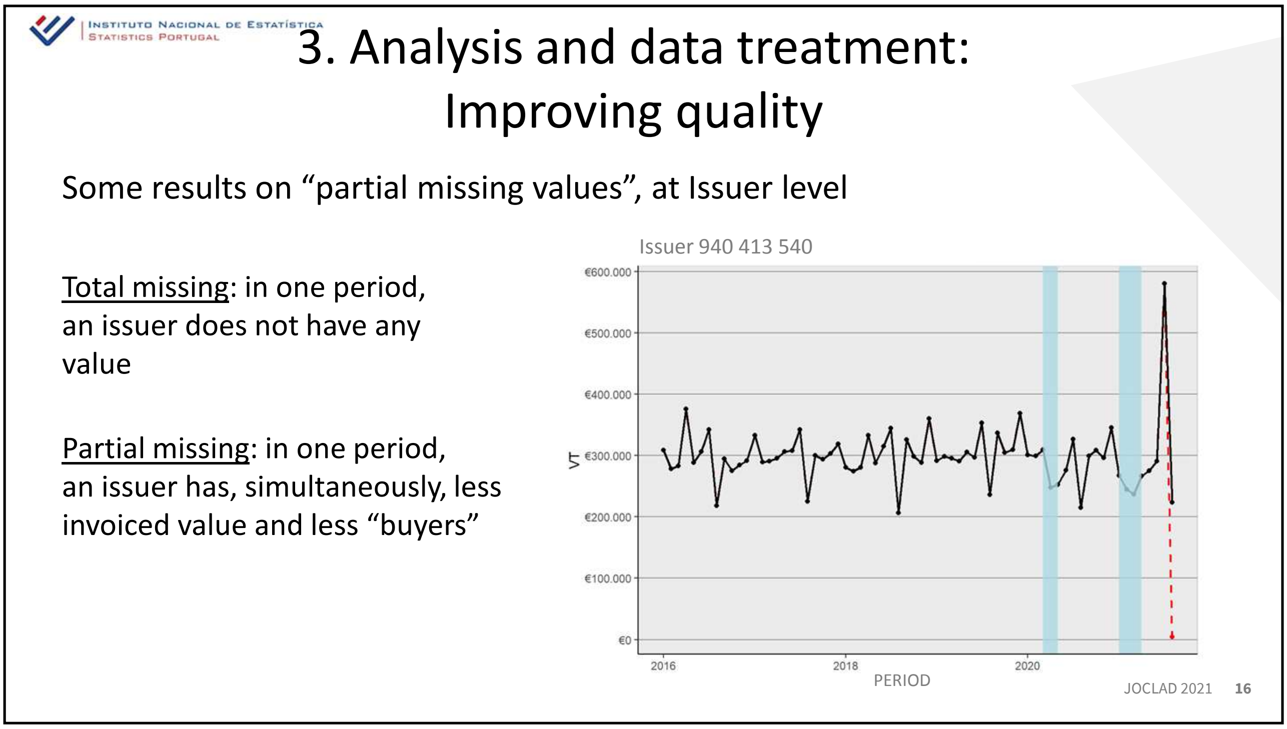
3. Analysis and data treatment: Improving quality

Some results on severe outliers identification and imputation, at NACE level

Before

After



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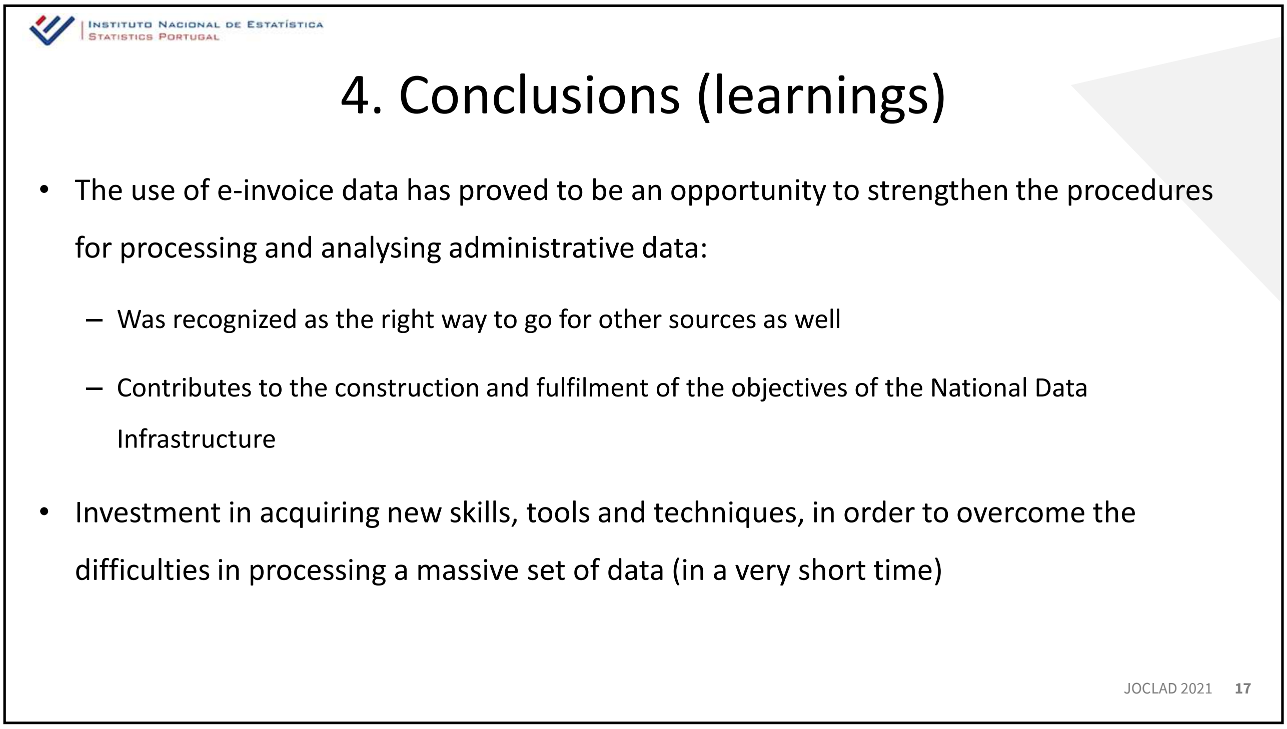
3. Analysis and data treatment: Improving quality

Some results on “partial missing values”, at Issuer level

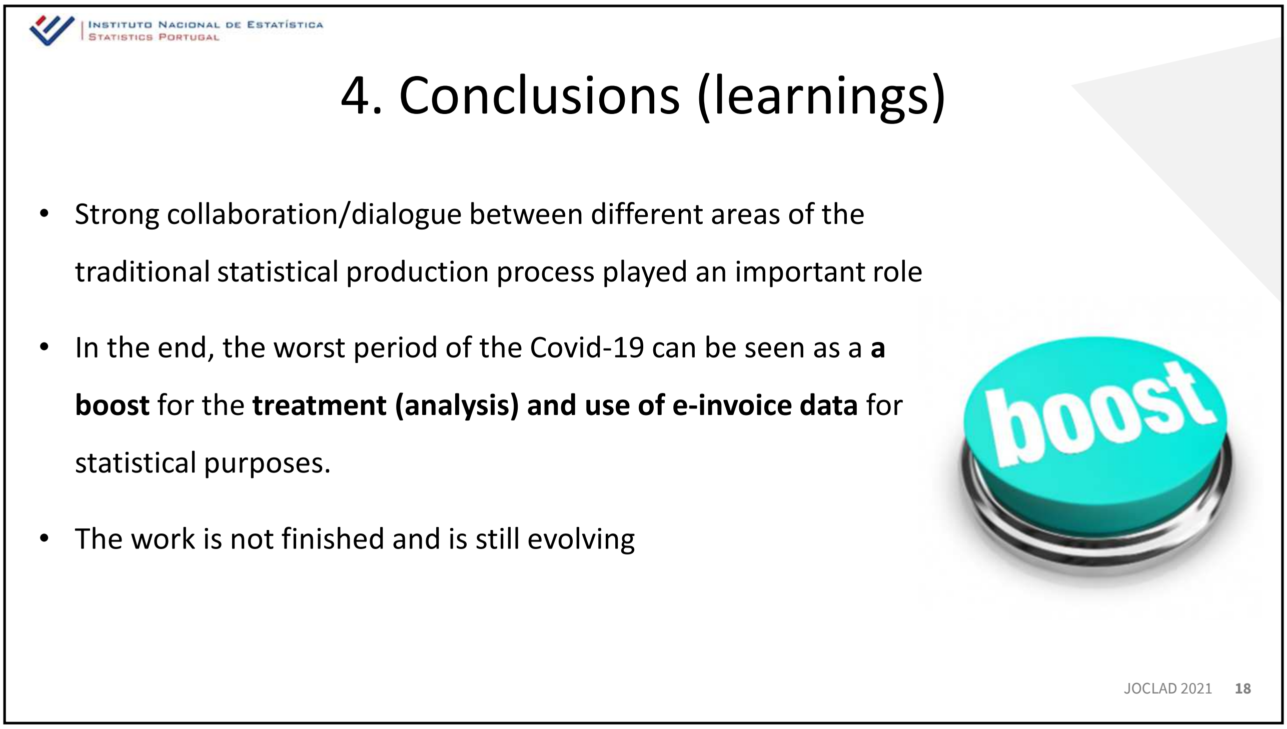
Total missing: in one period, an issuer does not have any value

Partial missing: in one period, an issuer has, simultaneously, less invoiced value and less “buyers”



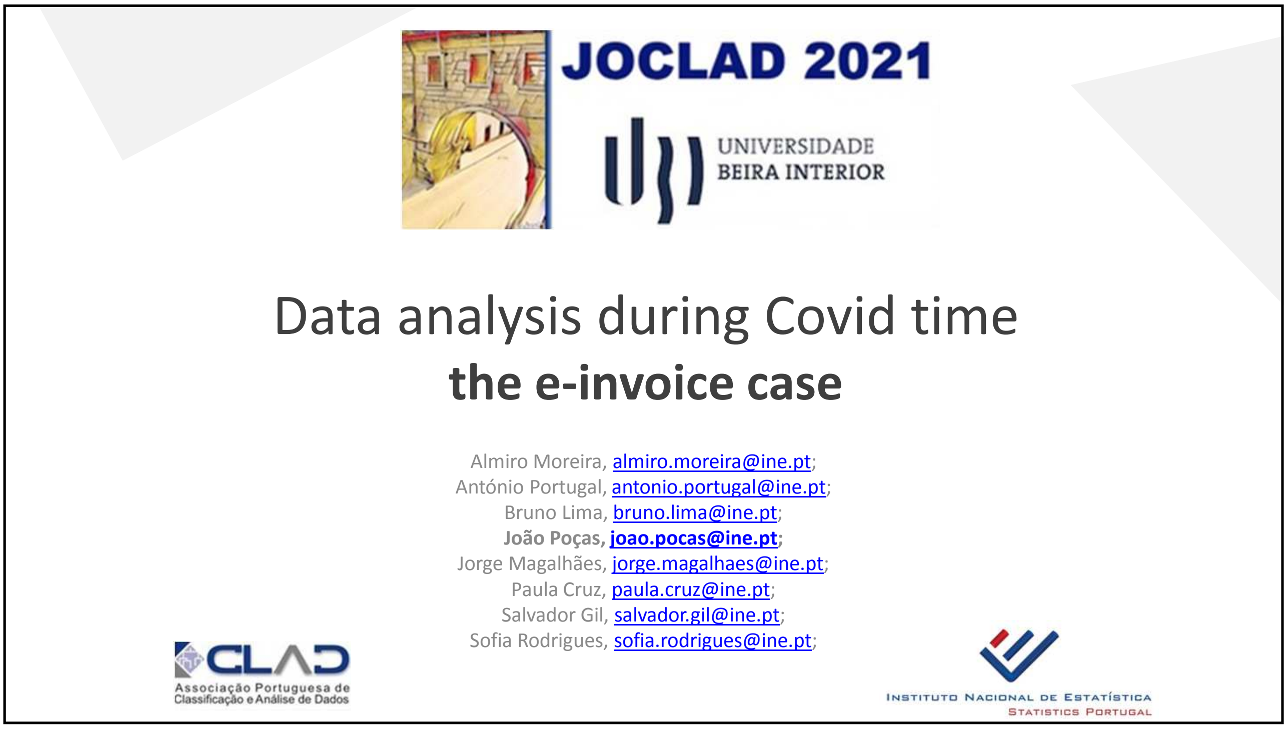
4. Conclusions (learnings)

- The use of e-invoice data has proved to be an opportunity to strengthen the procedures for processing and analysing administrative data:
  - Was recognized as the right way to go for other sources as well
  - Contributes to the construction and fulfilment of the objectives of the National Data Infrastructure
- Investment in acquiring new skills, tools and techniques, in order to overcome the difficulties in processing a massive set of data (in a very short time)



4. Conclusions (learnings)

- Strong collaboration/dialogue between different areas of the traditional statistical production process played an important role
- In the end, the worst period of the Covid-19 can be seen as a **a boost** for the **treatment (analysis) and use of e-invoice data** for statistical purposes.
- The work is not finished and is still evolving



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