

# Linked Open Data and the transformation of coinage weight

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## 1. Introduction

In the Roman Empire, the value of a denomination is subject both to, gradual and abrupt, changes. These can be partly explained by historically documented events (BUTCHER – PONTING 1995; PENSE 1992).

By measuring the physical characteristics of coins (i.e. their weight), changes through time can be documented. Not only can historically recorded coin reforms be identified, but it is also possible to recognize unrecorded shifts. Thus, a reduction in the weight of a coin can be traced back to the devaluation of a denomination. The denarius and antoninian are devalued by adding an increasing amount of copper alloy to the silver until a billon alloy is created. In the case of the aureus and sestertius, the devaluation occurs through a reduction in weight.

Previous metrological studies attempted to find the target weight of newly minted coins using coins that were as freshly minted and as intact as possible. These coins were sourced mostly from collections and museums. However, their state of preservation diverges from that of coin-finds (e.g., WALKER 1976; MACDOWALL 1979; PENSE 1992; DUNCAN-JONES 1994; BUTCHER – PONTING 1995; BUTCHER – PONTING 2012; BUTCHER ET AL. 2014; ELLIOTT 2014).

## 2. Main Aim

The qualitative approach of metrological examination of coin weights is to be contrasted with a quantitative approach, supported by Linked Open Data (GRUBER ET AL. 2013). If the results are consistent with the qualitative approach, well founded statements on coin reforms can be made with SPARQL-queries resulting in a time saving method.

Therefore: can a query using Linked Open Data capture the changes in value through changes in the weight of a denomination and assign them to historically documented events?

## 3. Method

The coinage reform of Nero in AD 64, after the Great Fire of Rome, is a well-known event and thus a suitable test object (Figure 3). Two denominations – aureus and denarius – will be presented before and after the reform and compared with the results of BUTCHER ET AL. 2014 and WALKER 1976, who both followed a qualitative approach.

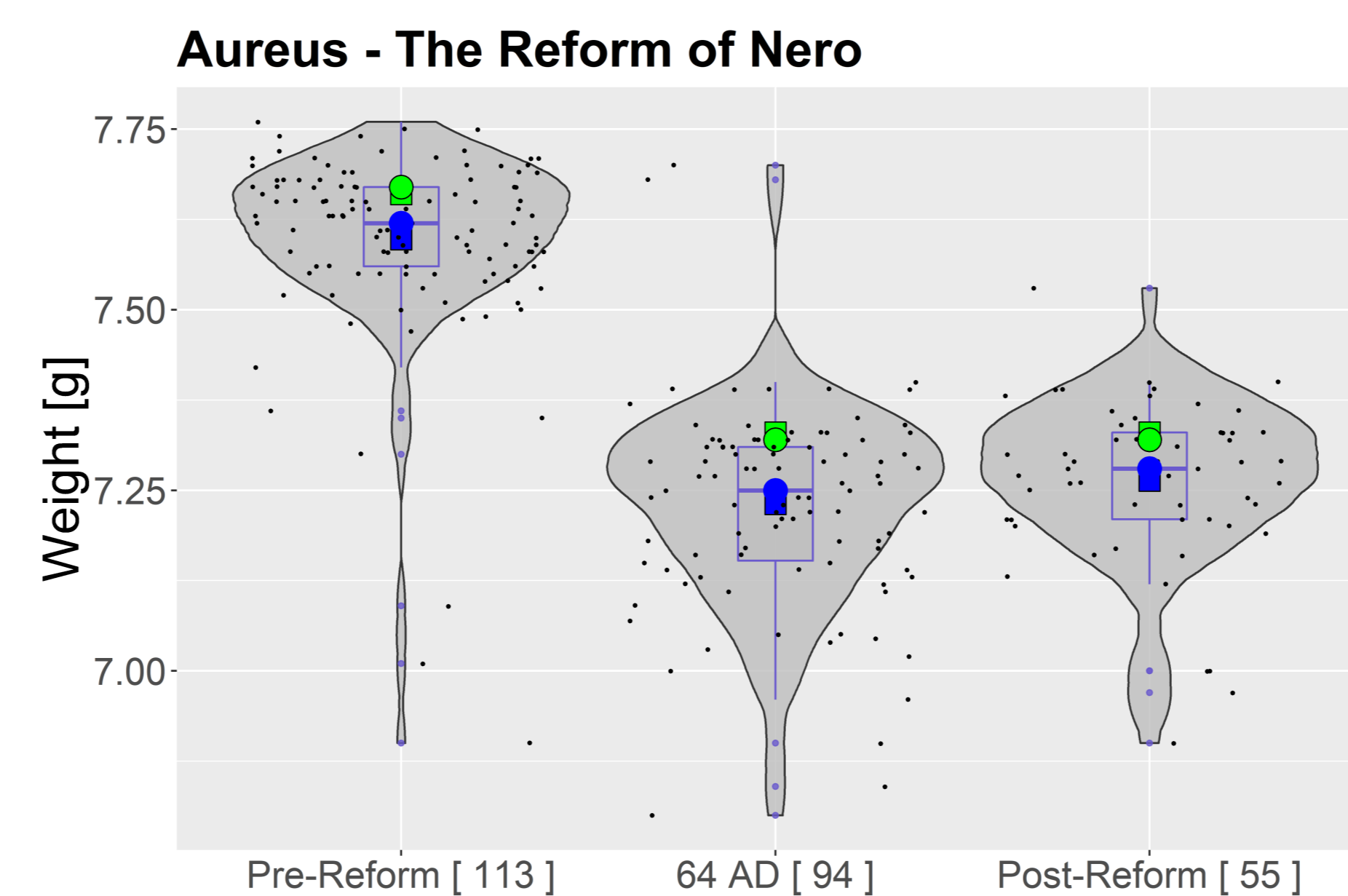
The database-interface OCRE, accessed through the SPARQL (SPARQL Protocol and RDF Query Language) endpoint of nomisma.org, is used in our case study. All coins of the queried denominations, from collections that are linked to OCRE, are taken into the statistical analyses. A SPARQL query is used for data acquisition and executed from within an R script. The search is limited to coins with a provided weight: the heaviest and lightest percent are discarded as probable outliers. Data visualization is implemented using a combination of violin and box plot to display the distribution of coin weights pre- and post-reform.

## 4. Results

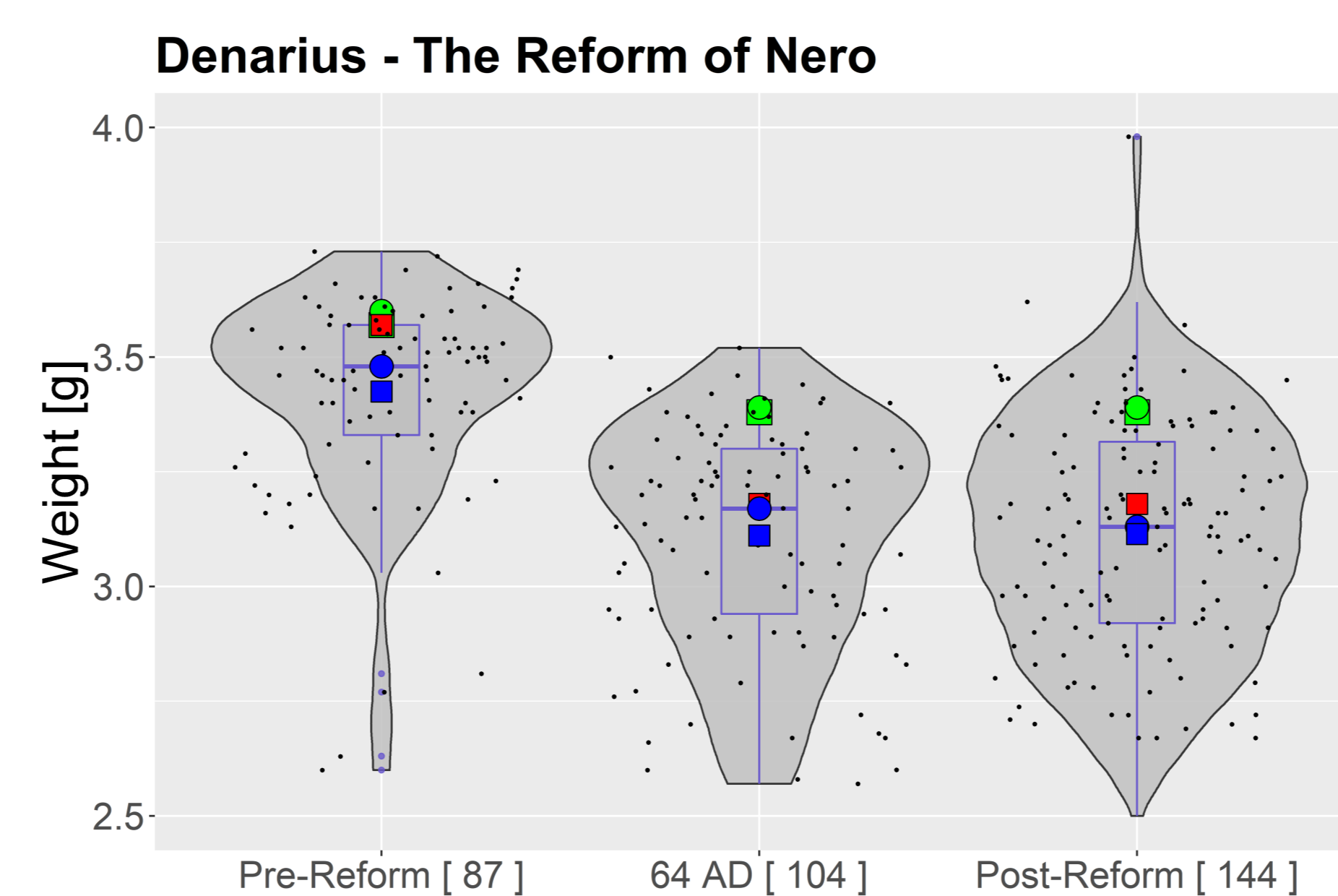
Aureus	pre-reform		64 AD		post-reform	
	mean	median	mean	median	mean	median
Quantitative Approach	7.60 g	7.62 g	7.23 g	7.25 g	7.26 g	7.28 g
BUTCHER ET AL. 2014	7.66 g	7.67 g	-	-	7.33 g	7.32 g
Denarius	pre-reform		64 AD		post-reform	
	mean	median	mean	median	mean	median
Quantitative Approach	3.42 g	3.48 g	3.06 g	3.14 g	3.15 g	3.12 g
BUTCHER ET AL. 2014	3.57 g	3.60 g	-	-	3.38 g	3.39 g
WALKER 1976	3.57 g	-	-	-	3.18 g	-

**Table 1:** Average and median weights of aurei and denarii according to the quantitative approach, BUTCHER ET AL. 2014 and WALKER 1976.

All methods show a clear break in the year of the coinage reform and afterwards for both denominations (Table 1). The shift in coin weight is equally pronounced by all approaches, although the quantitative approach seems to underestimate the mean and median slightly. This can be attributed to the wear of the coins, whereas the qualitative approach does not consider worn coins (Figures 1, 2).



**Figure 1:** Violin- and boxplot displaying the distribution of coinage weight of aurei. Square: mean; dot: median; blue: quantitative approach; green BUTCHER ET AL. 2014.



**Figure 2:** Violin- and boxplot displaying the distribution of coinage weight of denarii. Square: mean; dot: median; blue: quantitative approach; green BUTCHER ET AL. 2014; red: WALKER 1976.

## 5. Discussion

Using data acquisition with the SPARQL query and Linked Open Data, the weight fluctuations of the investigated nominals – aureus and denarius – can be well traced and therefore attributed to the coinage reform of Nero in 64 AD.

The comparison with the results of the qualitative analyses by BUTCHER ET AL. 2014 and WALKER 1976 shows that the quantitative method used here yields comparable results.

Linked Open Data offer advantages over the qualitative method, because once a query has been created, it is easier to update the data basis and is therefore an adequate tool for exploratory metrological studies. The digitization and integration of museum holdings and archaeological collections – especially coin finds of archaeological services – is therefore desirable.



**Figure 3:** Example of an aureus after the reform of Nero (7.29 g) (<http://numismatics.org/collection/1957.172.1533>)

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