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IN HONOUR OF
DR ELLEN RAVEN

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AN ANALYSIS OF THE GOLD CONTENT IN GUPTA GOLD COINS*

Pankaj TANDON**

Abstract – This paper analyzes XRF (x-ray fluorescence) data on the gold content of 362 Gupta coins, including the measurements of 194 coins by Sanjeev Kumar and 168 coins newly tested. The analysis shows that, during a major part of the Gupta period stretching from Candragupta II to Candragupta III, there was a declining trend in both the percentage and actual amount of gold in the coins. The results are statistically significant and perhaps indicate an increasing stress faced by the Guptas as their kingdom came under assault. After the reforms of Skandagupta, the actual gold content of the Gupta dinar jumped to a level higher than it had ever been before. Why Skandagupta pursued this monetary policy remains an open question. A preliminary analysis of the differences between coin types suggests that most types conformed to a standard for the coinage, but a few types appear to have had special status, which took the form of an enhanced gold content.

With the greater availability of technologies to test the metal content of coins, there is a growing literature on metal analyses and what they can tell us.^[1] In a recent paper (Tandon 2022), I used XRF analysis on a sample of Gupta gold coins to see what the evidence of gold content could tell us about the correct attribution of coins in the name of Candragupta. In this paper, I wish to report more fully the results of my testing and to conduct a preliminary study on what else we might be able to learn from the XRF analysis of the sample I studied in my earlier paper.

One particular aspect of studying the metal content that I find attractive is that this is an objectively measurable property of the coins. Traditionally, coins have been studied largely by their style and design. These properties are somewhat subjective and reasonable observers can have different interpretations of what they see. Looking at the measurable properties of coins eliminates the subjectivity. Further, with large enough samples, we can use statistical techniques to answer questions with greater precision. In an earlier paper (Tandon 2020), I looked at another measurable property of Gupta gold coins: their weights. Thus the 2022 paper and this one look to extend the study of Gupta gold coins to another measurable property, their metal content.

Specifically, I will look at what happens to the percentage gold content of the coins over time and find that, at least during an extended period covering the principal Gupta kings, it declined. Against this decline in the percentage gold content, we have the well-known and widely observed fact that the weights of the coins seem to rise over time. It becomes important, therefore, to look at what is happening to the actual gold content. It turns out that the actual gold content also declines during the main period, until the monetary reform of Skandagupta, when the weight of the Gupta dinar was dramatically increased. Finally, I break down the percentage composition and the actual gold content by type to see what insights we might gain. Surprisingly, there is a wide disparity between the gold content in the different types. This wide disparity leaves one wondering why Gresham's Law did not come into action. This Law states that "bad money drives out good," which means that when different purities of coins trade at the same rate in the marketplace, buyers and sellers have a strong incentive to hold on to the high purity coins, thereby withdrawing them from circulation.

One line of inquiry that I would have liked to have followed but was unable to do so was to look at the gold content by Ellen Raven's grouping system. This was impossible as I did not have a complete identification of the sample coins by Group. Hopefully Ellen will find this data compelling and will want to pursue this line of inquiry.

* Earlier versions of this paper were delivered to the International Numismatic Congress XVI in Warsaw in September 2022 and to the New York meeting of the Oriental Numismatic Society in January 2023. I am thankful to participants at these two meetings for their helpful comments, particularly Joe Cribb. I am also grateful to Ellen Raven for many discussions on Gupta coins over the years, including on this work as I was in the process of carrying out my research. It is indeed a pleasure to offer this paper to her in honor of her long career helping to unravel the mysteries of Gupta numismatics. A shorter, and somewhat different, version of this paper is due to be published in the INC XVI Proceedings volume, see Tandon 2023.

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[1] In particular, see the extensive studies of Maryse Blet-Lemarquand and her co-authors, such as Blet-Lemarquand 2006.

As I have already discussed my testing method and my sample in my earlier paper, I will not spend much time on those preliminaries. Suffice it to say that I have a sample of 362 coins, of which 194 were tested by Sanjeev Kumar, with the results published in his book (Kumar 2017, p. 93–96), and 168 that were tested by me. Detailed results of all the coins are provided in the Appendix. I felt it was necessary to include Kumar's coins in this table, as his attributions are different from mine, and therefore I needed to make clear how I am attributing the coins. The main differences in our attributions are that

- I assign the King and Queen coins to Samudragupta, not Candragupta I,
- I assign the Kāca coins also to Samudragupta and not to Rāmagupta,
- I assign the other coins Kumar attributes to Candragupta I (coins with the Goddess on the reverse depicted as being enthroned) to Candragupta II, and
- I assign the coins naming Candra of the “Belted Group” to Candragupta III, based on my argument in Tandon 2020 and Tandon 2022.

The merging of Kumar's sample with mine was shown in my 2022 paper to be warranted. Statistical tests showed that the mean percentage gold content of the principal kings in the two samples (for whom I had sufficiently many coins to make statistical testing feasible) were statistically the same, thus suggesting that the two samples (Kumar's and mine) were drawn randomly from the same population (the corpus of Gupta gold coins).

Percentage Gold Content

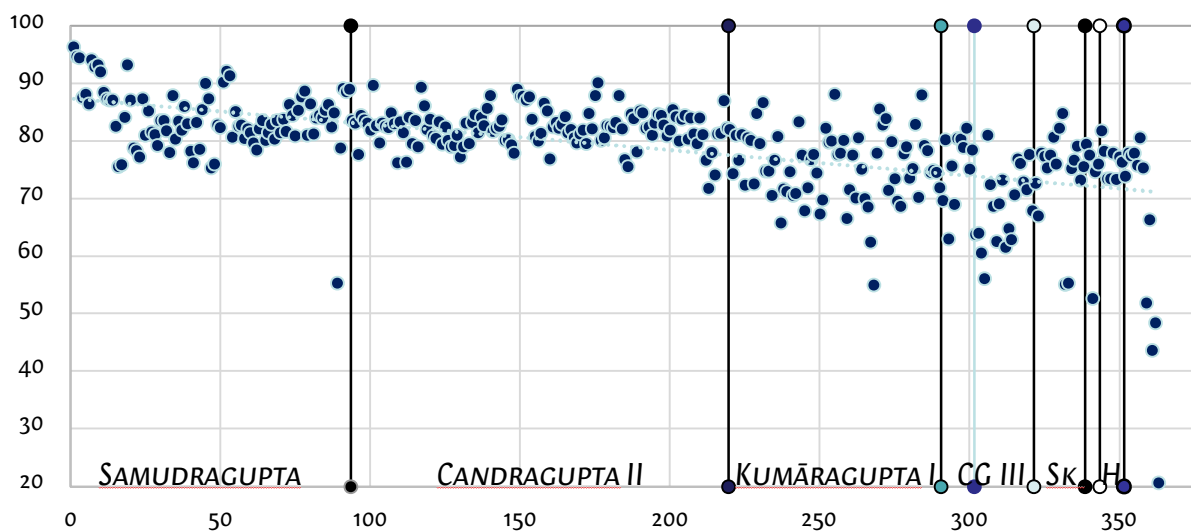


Figure 1 – Percentage Gold Content for each Coin in Sample

Let us turn now to the results of the XRF testing and begin our analyses. Figure 1 presents a scatter diagram showing the percentage gold content in each coin in the sample. The coins are arranged by king. Within each king, the coins are arranged alphabetically by type (except for Samudragupta, where the King and Queen coins are presented first, followed by other types in alphabetical order). Within each type for each king, the coins are arranged randomly in the order in which I happened to have them in my Excel file. For Candragupta II, this included putting all coins in which the Goddess on the reverse is seated on a throne first, followed by the coins where she is seated on a lotus. The Figure shows a basic and important result, not surprising but nevertheless important to demonstrate with data, that the percentage gold content seems to decline over time. Further, there seems to be a loss of quality control in that the variation in percentage gold content within the coinage of individual kings appears to widen over time. The detailed information on the metal content of each coin, specifying the percentage of gold, silver and copper, along with the coin's weight (when known), is presented in the Appendix.

Table 1 provides the average percentage gold content for each king and Figure 2 illustrates the same information in the form of a chart, in which each king's average percentage gold content is identified by the mid-point year of his reign. We see that over the first 100 plus years of the Gupta dynastic rule (from Samudragupta to Candragupta III) the

percentage gold content consistently declined. The observed reduction in gold percentage is highly significant statistically. The last column of Table 1 shows the P-values of the t-tests comparing the average gold percentage of each of those king's coins with the average for his predecessor. Any P-value below 5% is considered significant, indicating that the observed difference is real. Note that these P-values are for the two-tailed tests; if we had started with the alternative hypothesis that the percentage gold content is *lower* (rather than just different, a very reasonable approach), the P-values would be half the values shown in the table (since the appropriate test would be a one-tailed test). So from the time of Samudragupta to that of Candragupta III, the percentage gold content was clearly declining. During Skandagupta's reign, the tide was turned and, although the percentage gold content never returned to the levels it had attained during the reigns of Samudragupta and Candragupta II, over the next 50 years or so it remained roughly constant at the level maintained during the reign of Kumāragupta I. Then, in the sixth century, it declined precipitously.

King	Avg Au %	#Coins	Approx. Dates ^[2]	P-value
Samudragupta	83.96	93	335-380	
Candragupta II	82.31	126	380-413	1.18%
Kumāragupta I	75.77	71	413-447	<0.01%
Candragupta III	71.23	31	447-456	0.15%
Skandagupta	74.14	16	456-467	
Kumāragupta II	77.56	3	470-475	
Budhagupta	75.37	2	475-495	
Huns	76.51	8	495-515	
Narasimhagupta	77.26	6	505-520	
Kumāragupta III	64.55	3	520-525	
Viṣṇugupta	37.56	3	525-545	
TOTAL		362		

Table 1 – Average Percentage Gold Content, by King

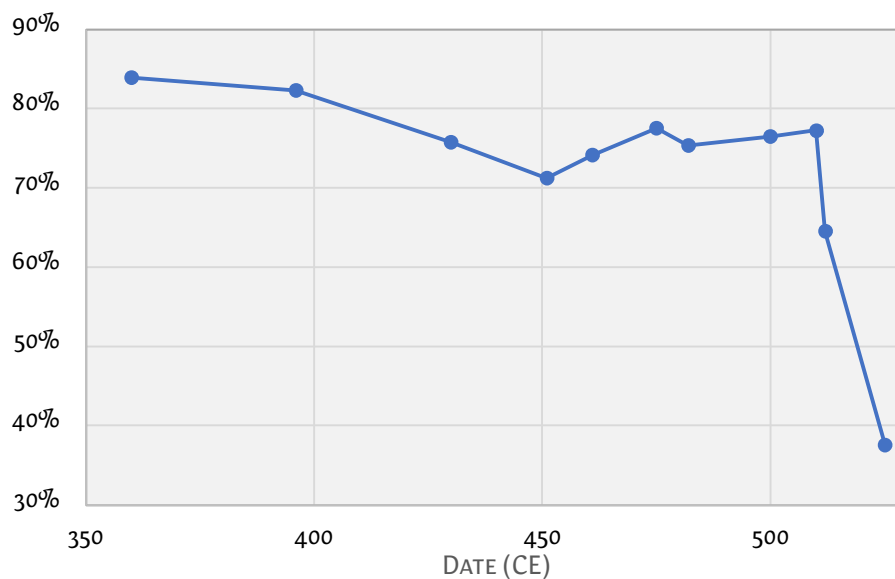


Figure 2 – Average Gold Percentage, by King (dated)

^[2] The approximate regnal dates are modified from Willis 2005.

The rise in gold percentage during the reign of Skandagupta is highly unusual and begs an explanation. Generally, the gold purity tends to decline over time in the case of most dynasties. So why did Skandagupta choose to raise the gold purity as he did? Indeed, this may be one of the manifestations of what Skandagupta expressly claimed in his Bhitari pillar inscription that he restored “the fallen fortune of (his) family” and “established again the ruined fortunes of (his) lineage.”^[3] We can infer from this that the decline in gold purity, particularly in the time of Candragupta III, must have disturbed the economic equilibrium of the time and caused some dislocation in trade and commerce. The restoration of the gold purity to the level it had attained during the reign of Kumāragupta I must have worked to restore an environment in which ordinary economic activity could flourish.

Actual Gold Content

If the average weight of the Gupta dinars had stayed constant over time, it would be sufficient to look at the percentage gold content to determine the trend in the intrinsic value of the coinage. However, as is widely known and understood, the average weight of the Gupta dinars did not stay constant; rather, it rose over time. Table 2 shows the average weights of the dinars of different kings from the sample of 1,608^[4] coins I studied in Tandon (2020), where the sample is described in detail. Figure 3 shows the same information graphically. The rising trend in average weight is quite consistent throughout the dynasty, except for the small downtick at the very end during the reign of Viṣṇugupta.

The rising weight acts as a counterbalance to the falling gold percentage, leaving open the question of what is happening to the actual or physical amount of gold in the coins. That, after all, is a measure of the true value of the coins. We must therefore look at the actual amount of gold in the coins. Figure 4 is a scatter diagram of all the coins in the sample for which the actual gold content can be calculated; for each coin, I have multiplied the weight of the coin by its gold percentage to arrive at the figure for actual gold content. A few coins in the original sample had to be excluded because their weight was not available, usually because there was a jewelry clasp or hook attached to the coin. We see from the diagram that the overall impression is of an actual gold content that seems to stay approximately constant through the Gupta period. The trend line is almost exactly flat at a value of 6.32g and the regression coefficient is not statistically different from zero.

King	Avg Weight	#Coins
Samudragupta	7.52	426
Candragupta II	7.77	554
Kumāragupta I	8.04	285
Candragupta III	8.24	107
Skandagupta	8.90	74
Kumāragupta II	9.18	13
Budhagupta	9.29	3
Huns	9.27	36
Vainyagupta	9.44	3
Narasimhagupta	9.45	52
Kumāragupta III	9.57	23
Viṣṇugupta	9.53	32

Table 2 – Average Weight of Gupta dinars, by King

^[3] See Gupta 1974, p. 41.

^[4] The observant reader would notice that the sample in my 2020 paper consisted of 1,609 coins. That number is reduced by one as I have discarded data for a coin of Budhagupta about which I had some doubts, and which has now been shown by the XRF testing to be a forgery.

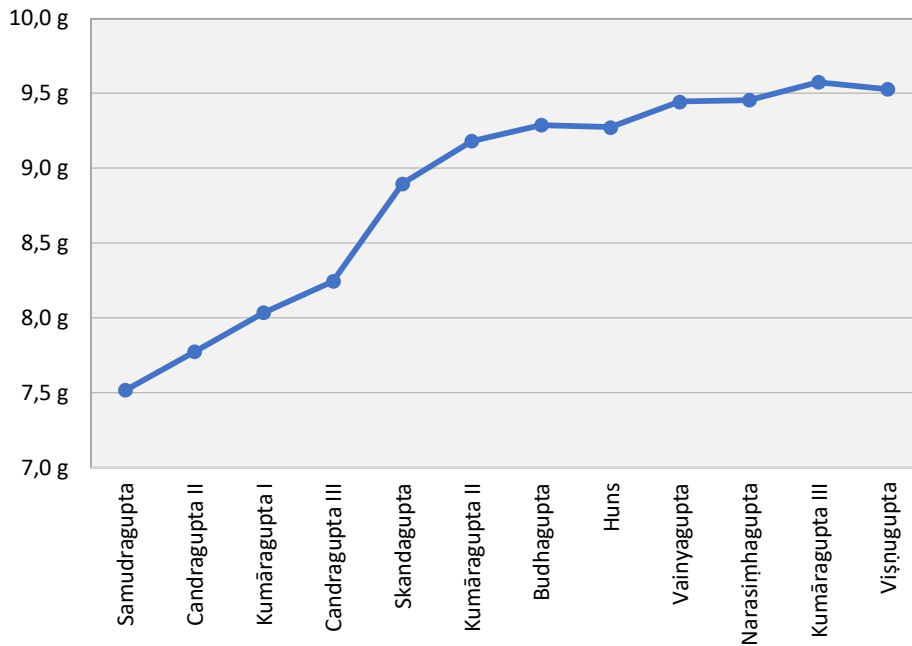


Figure 3 – Avg Weight of Gupta dinars, by King

However, if we break down the data by king, a more complicated story unfolds. Table 3 and Figure 5 show the average actual gold content by king. We see that there is an increase in the average actual gold content from 6.32g to 6.41g under Candragupta II as compared to his predecessor, Samudragupta; although it turns out that this increase is not statistically significant. From Candragupta II to Kumāragupta I there is a decrease in average actual gold content to 6.17g and there is a further decrease to 5.92g in the reign of Candragupta III. Remember that Samudragupta acceded to the throne in c. 335 and the last year of Candragupta III was c. 456, so these four reigns cover a period of approximately 120 years. Skandagupta appears to have carried out a major monetary reform. We have already noted that the percentage gold content in his coins shows a significant increase, but he also increased the weight dramatically, so that the average actual gold content rose to 6.52g, a level not seen previously in the dynasty's coins. The next few kings all had an even higher average gold content, until finally the gold content collapsed during the reign of Viṣṇugupta, falling to a highly debased level of 3.41g. Indeed, the coins of Viṣṇugupta contained more silver than gold.

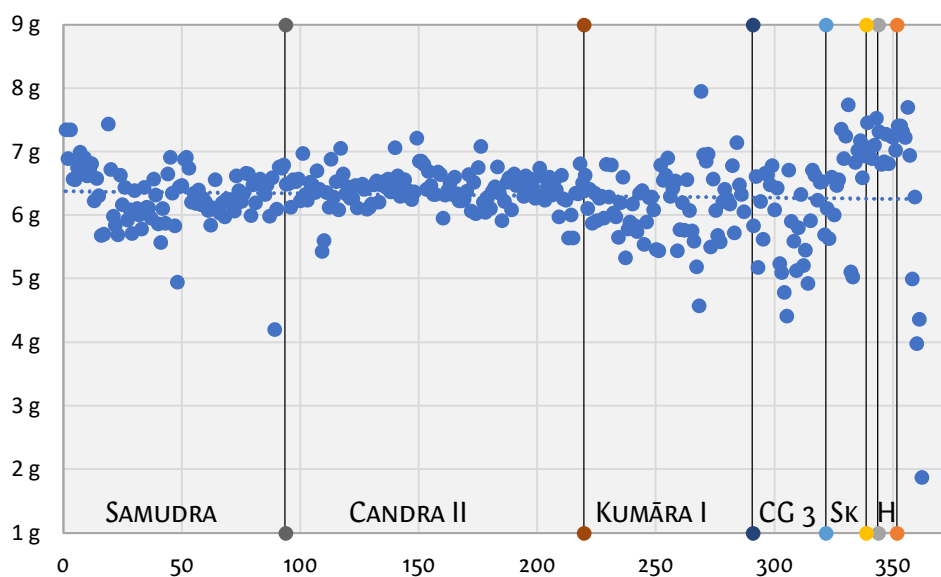


Figure 4 – Actual Gold Content (g) of all Coins in the Sample

King	Avg AU (g)	#coins
Samudragupta	6.32	92
Candragupta II	6.41	125
Kumāragupta I	6.17	67
Candragupta III	5.92	31
Skandagupta	6.52	16
Kumāragupta II	7.15	3
Budhagupta	7.00	2
Huns	7.13	8
Narasimhagupta	7.35	6
Kumāragupta III	6.08	3
Viṣṇugupta	3.41	3
TOTAL		356^[5]

Table 3 – Actual Gold Content, by King

Table 3 shows the number of coins we have for each king in the XRF sample. We can see that the number of coins for each of the first four kings is above 30, which number is often used as a dividing line between what we call a “large” or a “small” sample. Having a “large” sample is important because the degree of confidence we have in any statistical analysis rises as the sample we have gets larger. In the case of our sample, therefore, we can have a high degree of confidence in any statistical testing we do on the coins of the first four kings; not so much for the later kings, for whom we have fewer coins.

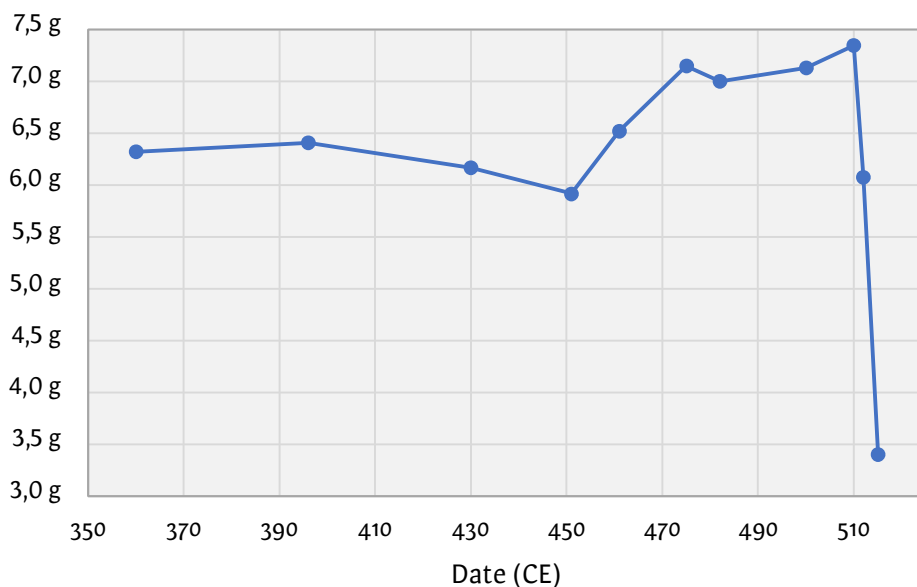


Figure 5 – Average Actual Gold Content (in g), by King (dated)

^[5] The number of coins here is lower than the number in Table 1 because there were 6 coins whose weight could not be accurately ascertained as they had attached clasps or loops from their use in jewelry. Hence the actual gold content could not be determined for these coins.

Table 4 summarizes the results on statistical tests aimed at answering the question: Is the difference in average actual gold content in the coins of two successive kings statistically significant or not? What we see is that, although the average actual gold content rises from 6.32g to 6.41g between the reigns of Samudragupta and Chandragupta II, this difference is not statistically significant. The P-value is 11.98%, indicating that the probability that we could have found a difference in average actual gold content to be this large (or larger), even though the true average actual gold content is the same, is nearly 12%. This is considered a high enough chance that we cannot reject the hypothesis that indeed the two averages are the same. The cutoff for significance is generally set at 5% by most researchers. Thus we conclude that the coins of Candragupta II did not have a significantly higher actual gold content than the coins of Samudragupta.

King	Avg AU (g)	Difference from Prior	P-value
Samudragupta	6.32		
Candragupta II	6.41	0.11	11.98%
Kumāragupta I	6.17	-0.24	< 0.01%
Candragupta III	5.92	-0.25	3.62%

Table 4 – Results of Statistical Tests on Actual Gold Content

However, if we look at the difference between the average actual gold content of the coins of Candragupta II and Kumāragupta I (6.41 g versus 6.17 g), we find that this difference is statistically significant, with a P-value vanishingly small at well under 0.01%. In other words, it would have been virtually impossible to have found the difference in average contents to be so large if the true average contents were actually the same. Similarly, we find that the change in average gold content between the reigns of Kumāragupta I and Candragupta III (6.17 g to 5.92 g) is also statistically significant, with a P-value of 3.62%. In other words, during the period from Candragupta II to Candragupta III, the Gupta currency was truly being debased, an important finding and a window into the state of the Gupta economy.

It is worth mentioning here that, when I ran these tests on only those coins in the sample that were tested by Sanjeev Kumar, all of the differences were found to be statistically not significant. The same is true when I ran the tests using only the data from the coins in my sample. Each of these samples was too small to get statistically significant results. It was only when the samples were combined that we got significant results. This is a powerful illustration of the point that large samples are needed to perform statistically useful research; the larger the sample, the better.

The fact that the actual gold content of the Gupta coinage was declining is not surprising, as this is a common occurrence in coinages of individual dynasties. The fact that the weight of the Gupta dinars was growing would have made it difficult for goldsmiths to determine if the actual amount of gold was staying constant, and this might have been a reason why the weight of the coins was increased over time. However, the weight kept going up even after the monetary reform of Skandagupta, so it is not clear that these two intertemporal trends were truly related for this reason.

Gold Content by Coin Type

As is well known, the main Gupta kings issued many different types of coins. After Skandagupta, it seems that this assertion no longer held true, and the kings issued coins of the Archer type only. But the kings from Samudragupta to Skandagupta issued many different types. A natural question to ask is whether the gold content varied by the type. This is the question explored in this section.

Table 5 shows the average percentage gold content by king and coin type. It is hard to process such a mass of numbers, so I will try to break them down in a few salient ways to understand them better. But, before doing that, I want to note that how seriously we can take these numbers depends to at least some extent on the number of examples of each type we have in our sample; the more examples we have for a type, the more confident we can be that the number we have is meaningful in the sense of being truly representative of the type. Table 6 presents the number of coins of each type that we have.

	SG	CG 2	KG I	CG 3	SkG (8g)	SkG (9g)	KG 2	Budh	Huns	Nara	KG 3	Viṣṇu
Apratigha			81.08									
Archer	87.53	82.45	76.73	71.12	72.66	73.84	77.56	75.37	75.34	77.26	64.55	37.56
Aśvamedha	82.05		72.95									
Battle Axe	82.33											
Chattra		82.16	70.61		67.02							
Couch		83.61										
Elephant-rider			77.28									
Horseman		82.70	73.89	72.78					80.04			
Kāca	81.67											
Kārttikeya			84.14									
King & Queen	92.02				77.05							
Lion-Slayer		81.34	74.74									
Lyrism	84.85		88.08									
Sceptre	82.28	83.98										
Swordsman			82.05									
Tiger-Slayer	88.95		75.60									

Table 5 – Average Percentage Gold Content, by King and Coin Type

The numbers in Table 6 reveal what we know from casual observation also: for all kings other than Samudragupta, the Archer type was the canonical, or normal, type. For Samudragupta, the canonical type was the Sceptre type. Some might argue that the Horseman type might have been the most important type in the reign of Kumāragupta I, and indeed the number of Horseman coins in our sample exceeds the number of Archer coins for that king. Nevertheless, I am going to treat the Archer type as his normal issue and look at what happened to these “standard” issues over time.

	SG	CG II	KG I	CG 3	SkG (8g)	SkG (9g)	KG 2	Budh	Huns	Nara	KG 3	Viṣṇu
Apratigha			1									
Archer	4	58 / 57	17	29	1	10	3	2	6	6	3	3
Aśvamedha	10 / 9		2									
Battle Axe	10											
Chattra		15	1		1							
Couch		4										
Elephant-rider			3									
Horseman		23	25 / 24	2					2			
Kāca	10											
Kārttikeya			3									
King & Queen	10				4							
Lion-Slayer		24	11									
Lyrism	10		1									
Sceptre	36	2										
Swordsman			1									
Tiger-Slayer	3		6 / 3									
TOTAL	93	126	71	31	6	10	3	2	8	6	3	3

Table 6 – Number of Coins of Each Type in the Sample^[6]

^[6] The second number in certain cells is the number of coins of that type for which the actual gold content (in g) was available.

In addition to the “standard” issues (Sceptre type for Samudragupta and Archer type for the remaining kings), the most common and persistent types were the *Chattra*, Horseman and Lion-Slayer types. Collectively, these four series account for 278 of the 362 coins in the sample (77%), broken down as “Standard” series 48%, *Chattra* 5%, Horseman 14% and Lion-Slayer 10%. Figure 6 shows what is happening to the average percentage gold content for these four series. We see that they seem to move together in close tandem with one another. This perception is confirmed in the formal statistical analysis that follows a little later.

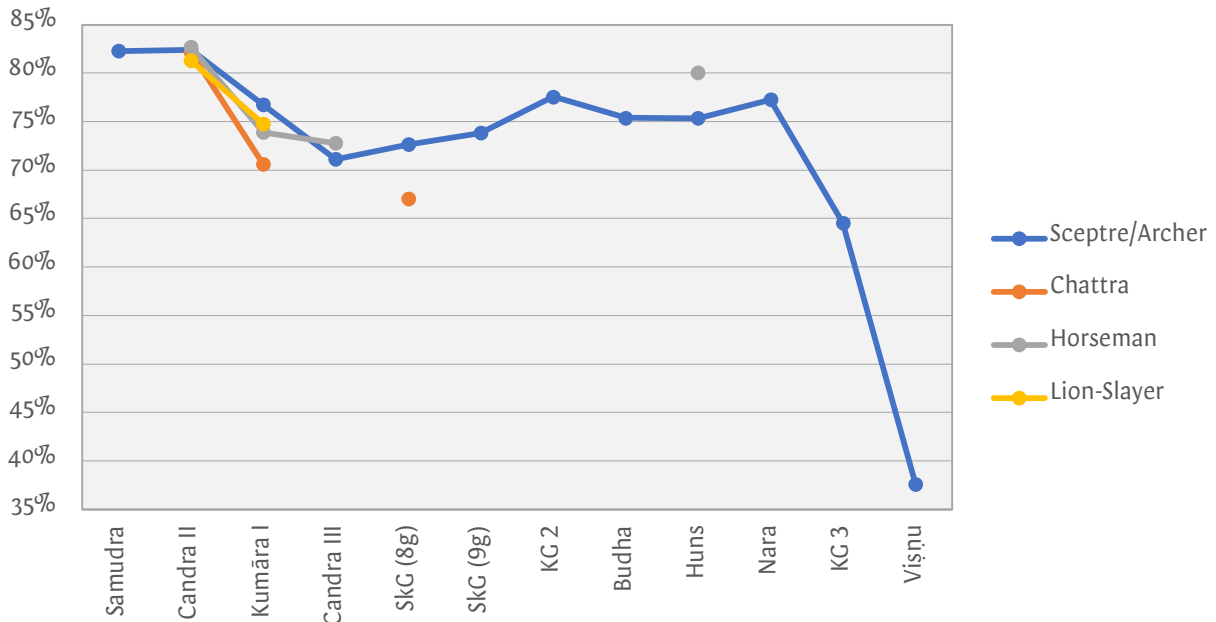


Figure 6 – Average Gold %, four principal Types

First, however, let us look at the variation in the actual gold content (in grams) in the different types. Table 7 shows the average actual gold content for each coin type for each king. The number of coins for each king/type is shown in Table 6, with the relevant number in cells where there are two numbers separated by a slash being the second number. Once again, it is difficult to digest this mass of numbers, so Figure 7 shows the average gold content for the four principal types graphically. This helps us to focus on the most important and abundant types.

	SG	CG 2	KG 1	CG 3	SkG (8 g)	SkG (9 g)	KG 2	Budh	Huns	Nara	KG 3	Viṣṇu
Apratigha			6.41									
Archer	6.59	6.44	6.13	5.90	6.10	6.70	7.15	7.00	7.03	7.35	6.08	3.41
Aśvamedha	6.22		6.04									
Battle Axe	6.11											
Chattra		6.39	5.83		5.64							
Couch		6.34										
Elephant-rider			6.16									
Horseman		6.41	6.08	6.11					7.42			
Kāca	6.12											
Kārttikeya			6.92									
King & Queen	6.89				6.41							
Lion-Slayer		6.34	6.09									
Lyrist	6.37		7.14									
Sceptre	6.22	6.55										
Swordsman			6.63									
Tiger-Slayer	6.77		6.29									

Table 7 – Average Actual Gold Content (g), by King and Coin Type

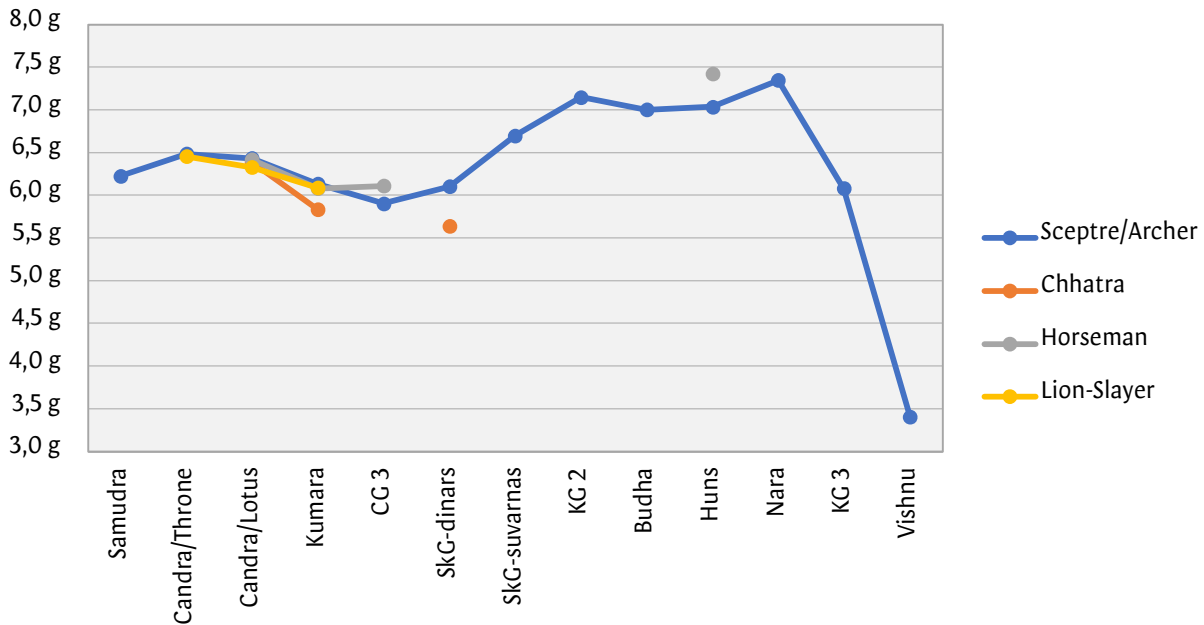


Figure 7 – Average Actual Gold Content (g), four principal Types

What we see from the Figure is that the average actual gold content is roughly constant through the reigns of the first four kings (Samudragupta to Candragupta III) and into what is presumed to be the early part of Skandagupta's reign, during which he was issuing coins of roughly 8.5g weight. Skandagupta then appears to have undertaken a massive monetary reform in which he raised the weight of the gold dinar dramatically to over 9g, while also marginally increasing the percentage gold content (see Table 5, the average percentage gold content rises from 72.66% to 73.84%). The result is an increase in the average actual gold content from 6.10g to 6.70 g. Skandagupta's successor, Kumāragupta II, has a further increase in the gold content to 7.15 g, and the graph shows that succeeding kings maintain or even increase the gold content until the reign of Kumāragupta III, when it falls to 6.08 g. The Gupta economy was probably under severe stress at this point, and during the reign of the last king, Viṣṇugupta, the debasement of the Gupta gold coinage reaches its nadir. The gold content at this point falls to 3.41g.

These results raise a rather obvious and vexing question: How could the late Gupta coins, of so much higher an intrinsic value, have traded one-for-one with coins of the earlier kings, whose coins had a significantly lower gold content? There is no evidence from inscriptions or any other source that the later coins traded at a premium. If they did trade one-for-one, Gresham's Law should have come into operation. "Bad money should have driven out good," meaning that the high value coins would not have been used as money, instead serving as a store of value and perhaps be melted down for their high gold content. It is possible, indeed plausible, that this did happen, which could account for the extreme rarity of the late Gupta coins, including those of Skandagupta. In future research, I will attempt to see whether we can find evidence of this in the coinage itself.

The previous analysis suggests that the main types of Gupta gold coins adhered roughly to the same standards of gold content as the canonical Sceptre/Archer coins. This suggestive statement is based on casual observation. To study the question of the differences in gold content by type in detail, including the study of the rarer types, I will look in detail at the differences king by king.

Samudragupta

To study the gold content in the coins of Samudragupta, I took his Sceptre type coins to be the canonical type. I calculated the average percentage gold content and average actual gold content for each type and then tested statistically if the averages of each type were significantly different or not from those of the Sceptre type. This is the same as testing if the differences between each type's averages and those of the Sceptre type were significantly distant from zero. It is worth pointing out that the number of coins for each type was quite low, so the statistical tests are not as robust as we would like. In particular, it is more difficult to find differences that are significantly distant from zero when the number of coins is small. When we **do** find significant results, despite the low number of observations, we can be quite sure that something significant is going on.

Table 8 presents the results for Samudragupta's coins. Both the percentage gold content and the actual gold content were tested. When the column marked "# Coins" has two numbers in it, the first number is the number of coins for which the percentage content was tested and the second number is the number of coins for which the actual gold content was tested. As we see, for most types the results were insignificant, indicating that we could not truly claim that the gold content for the specific types was that different than that of the Sceptre type. However, some results were significant, and these results are highlighted in bold. In terms of percentage gold content, the Archer, King & Queen, and Tiger-Slayer types all had significantly higher gold than the Sceptre type coins. This significant difference is maintained in terms of the actual gold content for the King & Queen and Tiger-Slayer types. For the Archer type, the average gold content is higher (6.59g as compared to 6.22g), but the P-value of the test is 9.10%. The cutoff for a significant result is normally taken to be 5%. Note that, for all the other types, the P-values are quite a bit higher than 5%, so it seems that these types were not really intended to be very different from the Sceptre type coins.

	# Coins	Percentage AU (%)			Actual AU (g)		
		Avg	Difference	P-value	Avg	Difference	P-value
Sceptre	36	82.28			6.22		
Archer	4	87.53	5.25	<0.01%	6.59	0.37	9.10%
Aśvamedha	10 / 9	82.05	-0.23	86.47%	6.22	0.00	99.62%
Battle Axe	10	82.33	0.05	96.95%	6.11	-0.11	39.12%
Kāca	10	81.67	-0.61	68.81%	6.12	-0.10	45.14%
King & Queen	10	92.02	9.74	<0.01%	6.89	0.67	<0.01%
Lyryst	10	84.85	2.57	21.61%	6.37	0.15	48.87%
Tiger-Slayer	3	88.95	6.67	<0.01%	6.77	0.55	<0.01%

Table 8 – Samudragupta: Differences in Gold Content, by Types

We can summarize the results for Samudragupta as follows: most types were quite similar in their gold content, but two types stood out for their higher gold content: the King & Queen and Tiger-Slayer types. The Archer type might also have been a special case with higher gold content, although the results are not quite as strong as for the other two types. Although the results were not significant, the Lyryst type coins also seemed to be somewhat different. It is possible that a finer classification, such as by mint, might reveal some interesting results.

We can also look at the results on the Samudragupta coins using a graphical analysis that yields additional insights. Figure 8 has two panels: panel (a) displays the results for the percentage gold content and panel (b) displays the results for the actual gold content. Each panel shows for each coin type a bar. The top of the bar shows the highest value attained within the sample for that coin type and the bottom of the bar shows the lowest value attained for that coin type. The pellet in the middle represents the average value. Let's look first at panel (a). Notice how the bars for the Archer, King & Queen, and Tiger-Slayer types all lie entirely above the average value for the Sceptre type. It is not surprising then that the values for these three types were shown to be significantly higher than the Sceptre types. The bars for all the other types bracket the average for the Sceptre type; it becomes statistically difficult then to claim that these values are significantly different from the value of the Sceptre type. The bars in panel (b) look very much like the ones in panel (a) except for the Archer type, whose bar now brackets the average for the Sceptre type. This mirrors our statistical result that the average actual gold content is no longer significantly different for the Archer type.

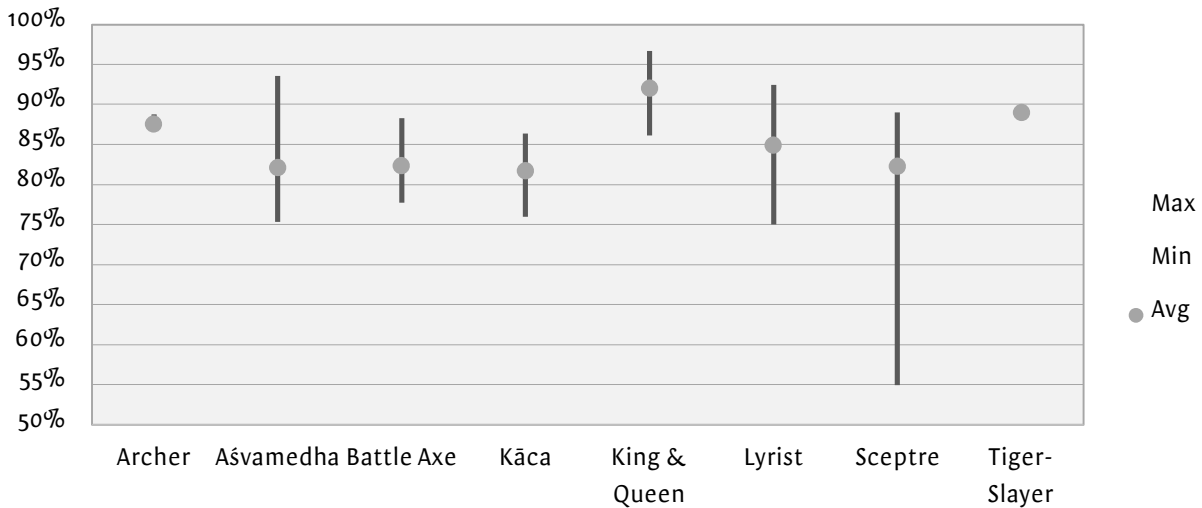


Figure 8(a) – Samudragupta: Differences in Percentage Gold Content, by Types

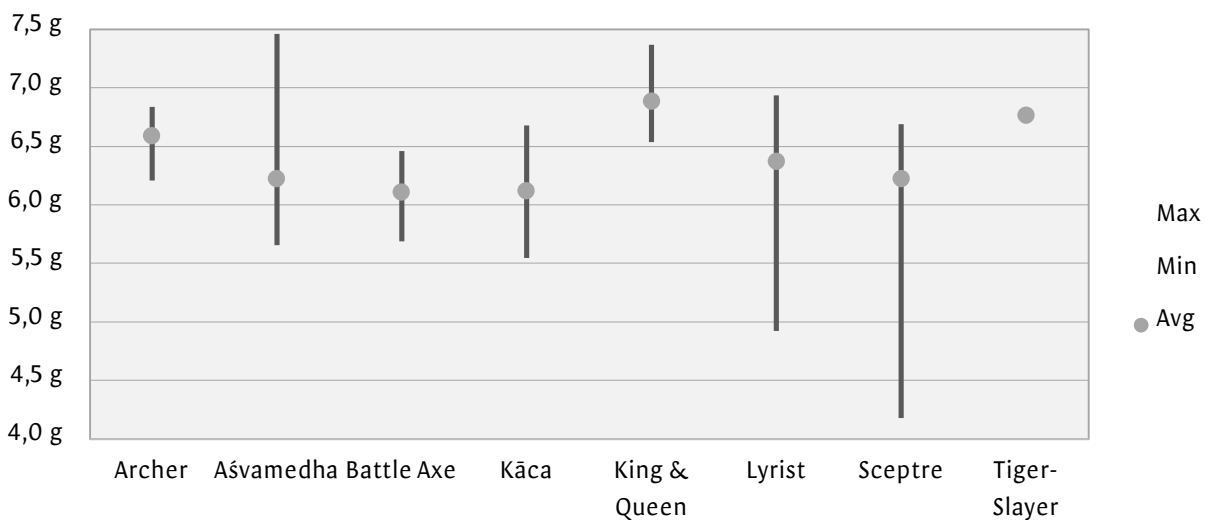


Figure 8(b) – Samudragupta: Differences in Actual Gold Content (g), by Types

Candragupta II

On the reasonable presumption that the coins with the goddess enthroned on the reverse pre-dated the coins with the goddess seated on a lotus, the first test I conducted on the coins of Candragupta II was to compare the gold content in the Archer coins with goddess on throne with the Archer coins with goddess on lotus. The results are presented in the first two lines of Table 9. Although the gold content is lower in the later coins, the difference is statistically insignificant. For the remaining tests, therefore, I dropped the distinction between these two sub-types and grouped all the Archer coins together.

The last six rows of Table 9 present these results. Of course, Candragupta's canonical type is taken to be the Archer type, and this will be the case for all subsequent kings. The results speak for themselves. The average percentage gold content and the average actual gold content seem fairly similar across all the types, and this casual impression is borne out by the statistical testing. No test reveals a significant difference from the Archer type. The one type for which there might be any suspicion is the Lion-Slayer type; surprisingly, the gold content here is *lower* than the Archer type coins. Nevertheless, since the statistical results point to no significant difference, we need not make much of this difference.

	# Coins	Percentage AU (%)			Actual AU (g)		
		Avg	Difference	P-value	Avg	Difference	P-value
Archer/Throne	10	82.98			6.45		
Archer/Lotus	48 / 47	82.33	-0.65	56.94%	6.43	-0.02	84.96%
Archer	58 / 57	82.45			6.44		
Chattra	15	82.16	-0.29	74.85%	6.39	-0.05	46.18%
Couch	4	83.61	1.16	49.38%	6.34	-0.10	56.18%
Horseman	23	82.70	0.25	75.51%	6.41	-0.03	77.34%
Lion-Slayer	24	81.34	-1.11	17.10%	6.34	-0.10	21.84%
Sceptre	2	83.98	1.53	51.06%	6.55	0.11	60.24%

Table 9 – Candragupta II: Differences in Gold Content, by Types

Figure 9 shows the maximum, minimum and average values for each type and we can see how the average for each type is well within the bounds of the values seen for the Archer type. It is not surprising, therefore, that none of the averages was statistically different from the value for the Archer type.

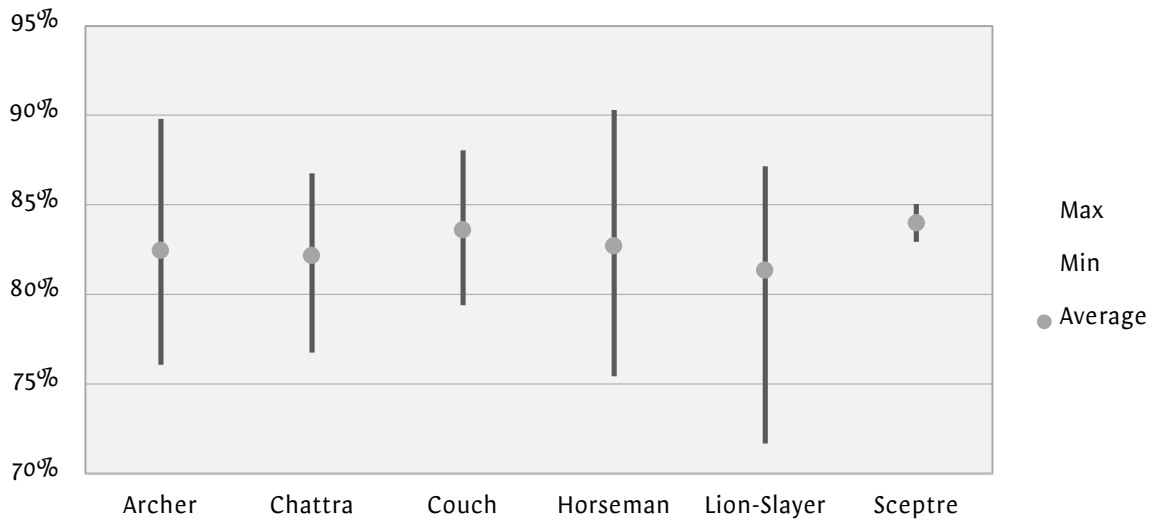


Figure 9(a) – Candragupta II: Differences in Percentage Gold Content, by Types

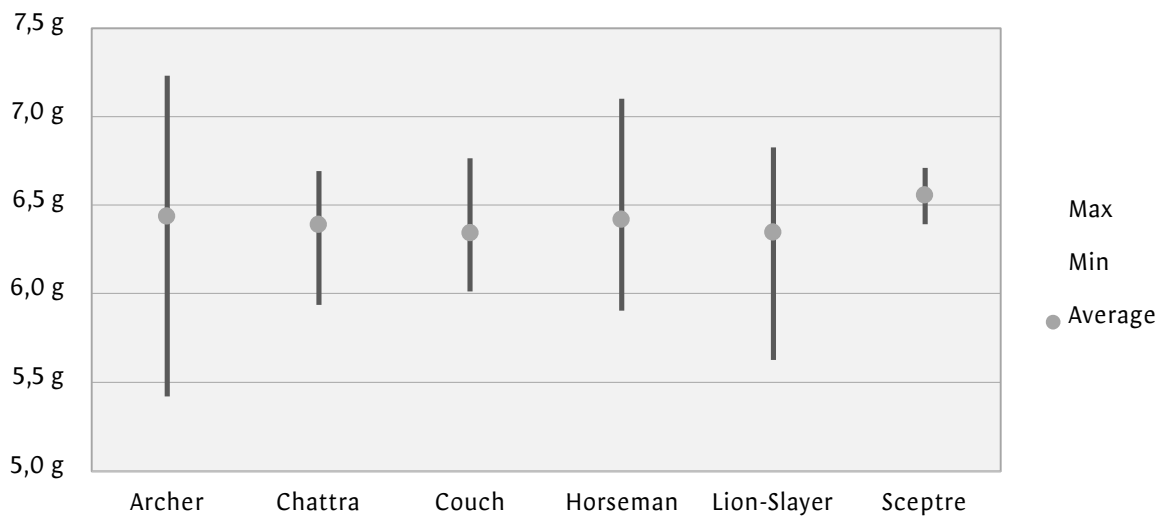


Figure 9(b) – Candragupta II: Differences in Actual Gold Content (g), by Types

Kumāragupta II

Table 10 and Figures 10(a) and 10(b) present the results for Kumāragupta I. By this time, the reader has become familiar with the presentations, and we need simply to summarize the key results. Statistically, we cannot separate the gold content of any of Kumāragupta's coin types from the canonical Archer type, except (see the results in **bold type**) for the Kārttikeya type, which has distinctly higher gold content, and possibly the Lyrist type, where the results for the one coin we have indicate the possibility that the gold content for this type may also have been intentionally higher than the normal coin types.

	# Coins	Percentage AU (%)			Actual AU (g)		
		Avg	Difference	P-value	Avg	Difference	P-value
Archer	17	76.73			6.13		
Apratigha	1	81.08	4.35	44.65%	6.41	0.28	49.97%
Aśvamedha	2	72.95	-8.13	35.28%	6.04	-0.09	75.24%
Chattra	1	70.61	-10.47	28.86%	5.83	-0.30	46.31%
Elephant-Rider	3	77.28	6.67	87.50%	6.16	0.03	91.38%
Horseman	25 / 24	73.89	-3.39	17.31%	6.00	-0.13	42.39%
Kārttikeya	3	84.14	10.24	3.32%	6.92	0.79	<0.01%
Lion-Slayer	11	74.74	-9.40	32.77%	6.09	-0.04	78.71%
Lyrist	1	88.08	13.33	5.87%	7.14	1.01	2.15%
Swordsman	1	82.05	-6.03	35.45%	6.63	0.50	22.77%
Tiger-Slayer	6 / 3	75.60	-6.45	63.26%	6.29	0.16	50.72%

Table 10 – Kumāragupta I: Differences in Gold Content by Types

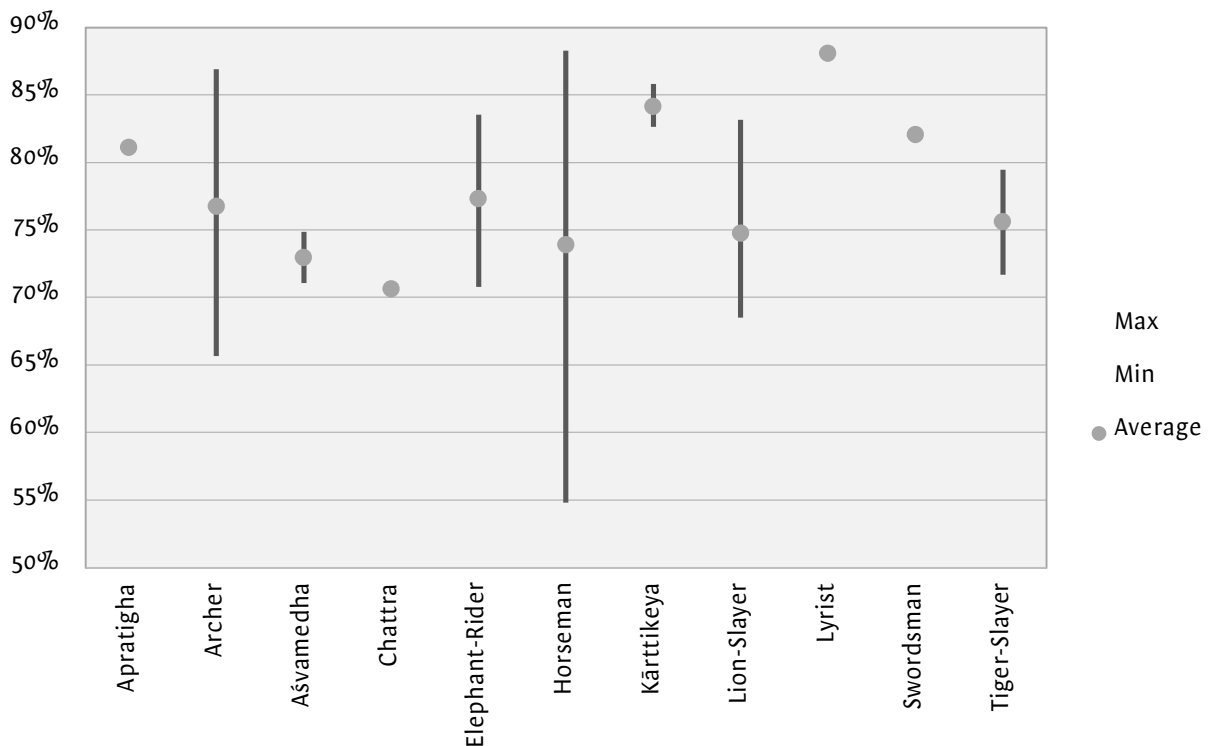


Figure 10(a) – Kumāragupta I: Differences in Percentage Gold Content, by Types

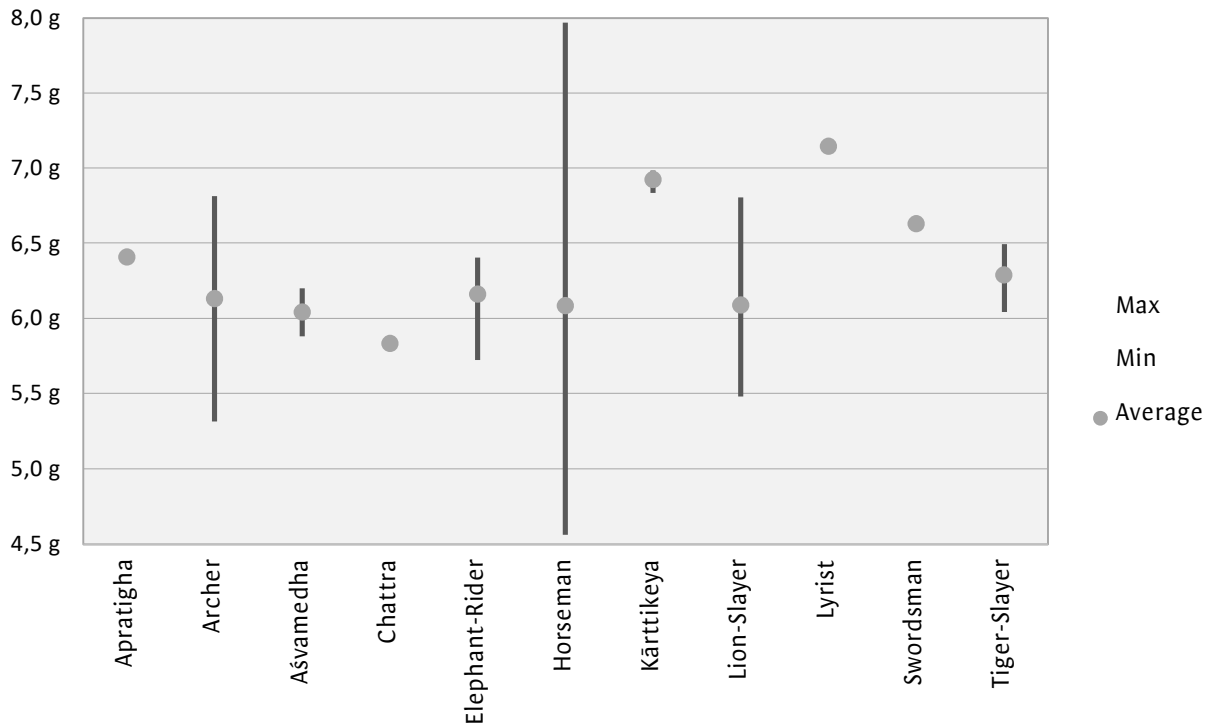


Figure 10(b) – Kumāragupta I: Differences in Actual Gold Content (g), by Types

Candragupta III

Before I report the results in this section, I want to take this opportunity to publish a *Chattra* type coin of Candragupta III, a coin I have just recently acquired. Its photo is in Figure 11. I had identified three *Chattra* type coins of this king in Tandon 2020. This coin displays the same style of legend as the first two coins in Figure 23 of that paper and the characteristic circle *tamgha* seen on many of his coins. I was able to test its metal composition and am reporting those results in what follows. Please note that the data from this coin is not included in any of the other analysis in this paper, as it was added after the rest of the paper had already been completed.



Figure 11 – *Chattra* type coin of Candragupta III
(Tandon collection #703.20, 8.18 g, 19 mm, ↑↑)

Table 11 and Figures 12(a) and 12(b) display the results for Candragupta III. So far, we know of only four types issued by that king, and we have no results from any Lion-Slayer type. Comparing the Horseman type coins and now this *Chattra* type coin with the Archer types, we find no significant statistical difference. However, I thought it would be interesting to compare two different groups of Archer type coins with one another: the so-called “Belted” types which were the subject of Tandon 2020 and the coins which feature a symbol in front of the king’s face. I think this comparison is interesting because it is quite clear that the Belted coins were issued earlier than the symbol coins, so we might get some insight into what was happening to the Gupta economy during the reign of Candragupta III.

	# Coins	Percentage AU (%)			Actual AU (g)		
		Avg	Difference	P-value	Avg	Difference	P-value
Archer	29	71.12			5.90		
Horseman	2	72.78	1.66	76.94%	6.11	0.21	68.05%
<i>Chattra</i>	1	76.48	5.36	47.72%	6.26	0.36	61.62%
Archer-Belted	11	75.77			6.23		
Archer-Symbol	18	68.29	-7.48	0.52%	5.70	-0.53	4.01%

Table 11 – Candragupta III: Differences in Gold Content, by Types

As I had suspected, we find a significant reduction in both the percentage and the actual gold content in the symbol coins as compared to the Belted coins (see the results in **bold** type), indicating that the Gupta economy was under severe stress during this time. The reign of Candragupta III was quite short, no more than eight years, so this dramatic reduction in the gold content does provide powerful evidence that the Gupta treasury was being strained at the time. The presumable culprit was war in the west.

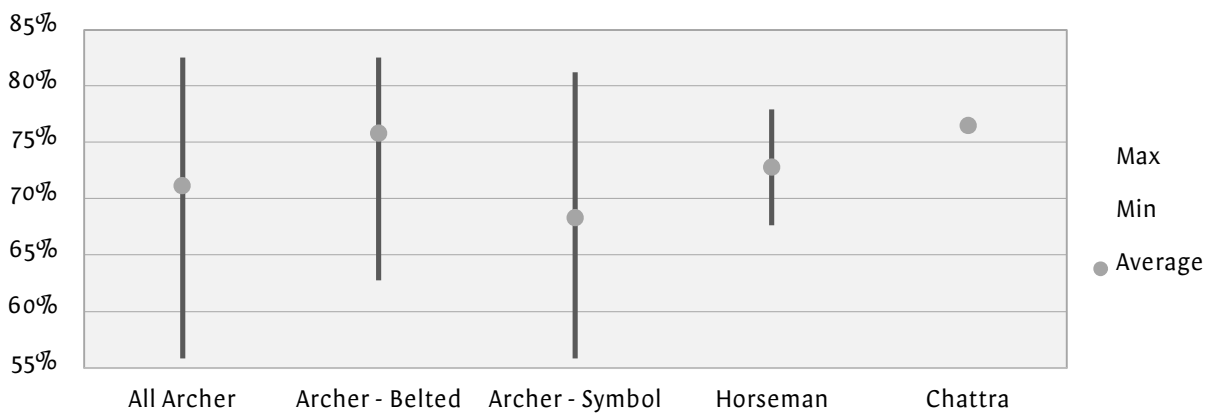


Figure 12(a) – Candragupta III: Differences in Percentage Gold Content, by Types

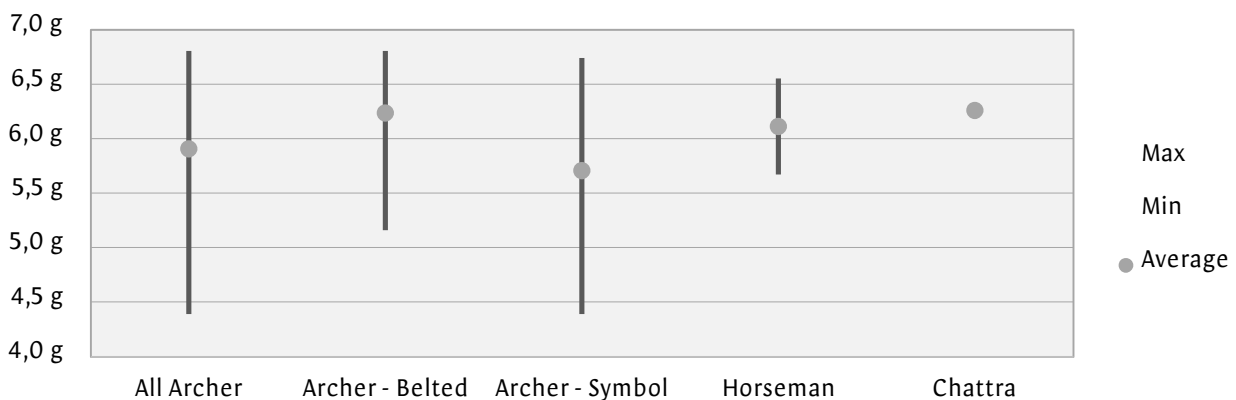


Figure 12(b) – Candragupta III: Differences in Actual Gold Content (g), by Types

Skandagupta

The last king for whom we have multiple types to test is Skandagupta. All the later Gupta kings issued coins only of the Archer type. With Skandagupta, we see a dramatic monetary reform, in which the weight of the dinar was raised to over 9g. We have no indication from inscriptions or other sources that this post-reform coinage was intended to be a different denomination than the pre-reform dinar, although some modern scholars have taken to calling the heavier coins by a different name: the *suvarṇa*.^[7] Here, however, I assume the post-reform coinage was intended to trade one-for-one with the pre-reform coinage.

	# Coins	Percentage AU (%)			Actual AU (g)		
		Avg	Difference	P-value	Avg	Difference	P-value
Pre-reform	6	74.65			6.23		
Post-reform	10	73.84	-0.81	83.12%	6.70	0.47	28.44%
All Archer	11	73.73					
Chattra	1	67.02	-6.71	53.00%	5.64	-1.00	30.14%
King & Queen	4	77.05	3.32	29.70%	6.41	-0.23	44.46%

Table 12 – Skandagupta: Differences in Gold Content, by Types

Nevertheless, I first tested the gold content of these two different groups of coins and the results are presented in Table 12 and Figures 13(a) and 13(b). The post-reform (heavy weight) coins had a slightly lower gold percentage but a roughly 0.5g higher actual gold content (see the first two rows in Table 12). However, these differences were not statistically significant. This result is perhaps driven at least in part by the small number of coins available for testing. It is quite possible that a larger sample would deliver significant results. However, based on the results obtained here, I merged the two groups for the following tests on types. These results also showed that we could not separate the gold content in the different types from one another. Again, I believe a larger sample is needed for us to explore these differences in a robust way.

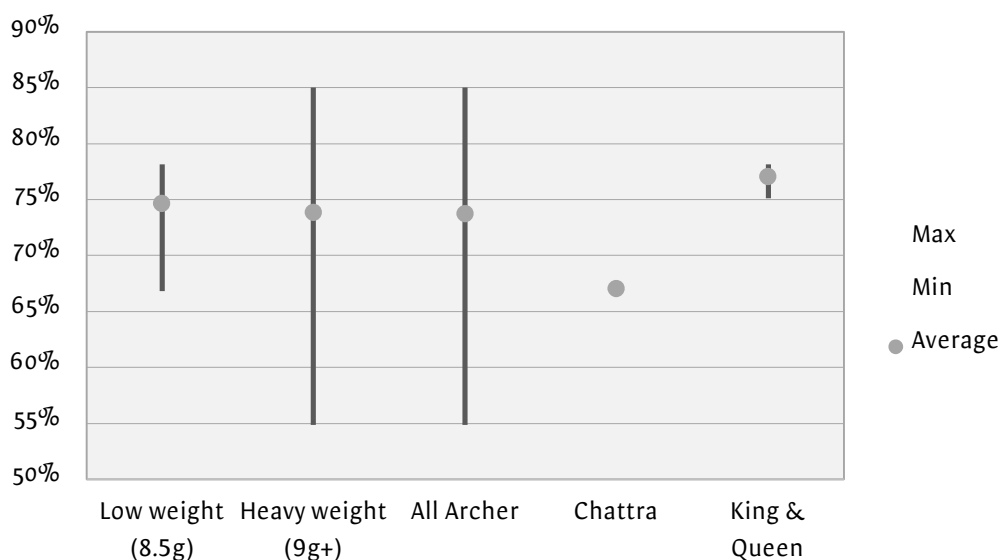


Figure 13(a) – Skandagupta: Differences in Percentage Gold Content, by Types

^[7] I examine the implications of the possibility that this post-reform was indeed intended to be a different denomination in Tandon 2023.

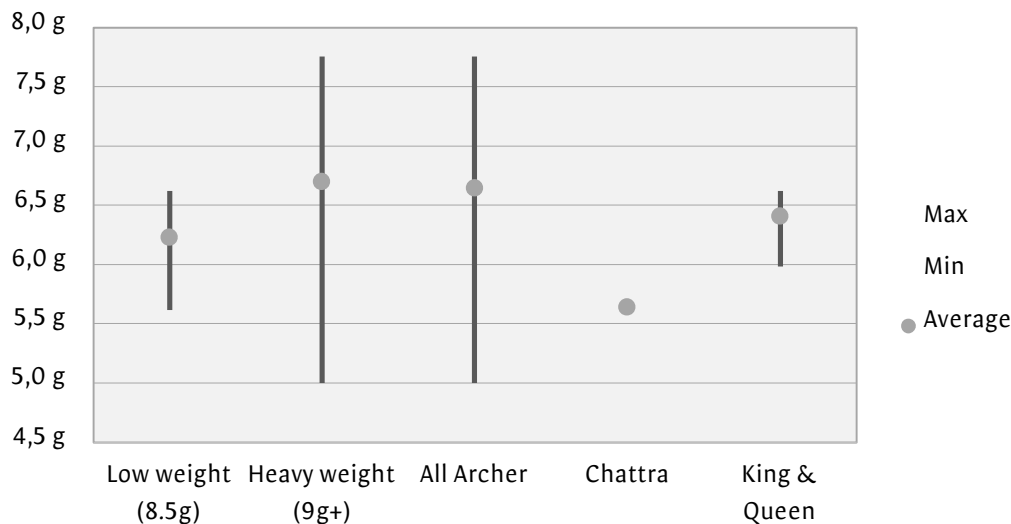


Figure 13(b) – Skandagupta: Differences in Actual Gold Content (g), by Types

Conclusion

What this study most reveals is the need for large samples in order to facilitate the use of statistical techniques in numismatics. Many of the statistical tests undertaken in this paper resulted in insignificant results; the culprit, in many cases, is no doubt the lack of a large enough sample. Nevertheless, some results have emerged.

At an aggregate level, we saw that the gold content of Gupta gold coins was falling initially, particularly from the reign of Candragupta II to Candragupta III. Skandagupta apparently undertook a significant monetary reform in which the weight and gold content of the coins was increased. Kumāragupta II continued this trend, and the subsequent kings maintained the gold content at the same level until the time of Viṣṇugupta, when the coinage was de-based substantially. Why Skandagupta undertook that dramatic monetary reform is not at all clear. One interesting hypothesis emerges from this analysis. It is well known that the coins of the kings after Skandagupta are very rare; even Skandagupta's coins are not plentiful in comparison to all of his predecessors. I for one had always thought that the rarity of late Gupta coins was due to the fact that the coinage itself was quite limited, reflecting a much reduced economy. The gold content analysis suggests an alternative hypothesis: that the rarity of late Gupta coins is a manifestation of Gresham's Law at work. If the late Gupta coins were intended to trade on a par with the coins of the earlier rulers, consumers would not have used them for trade. They would have preferred to melt them down to realize the higher intrinsic value of their contents. I will try to test this hypothesis in my future research.

At the level of the individual coin types, much less can be said definitively. There is some indication that most types conformed to the standards of the "normal" types of each king, the Sceptre type for Samudragupta and the Archer type for everyone else. There were some types that seemed to have special status, as a result of which their gold content was enhanced. The King & Queen type and Lyrist type of Samudragupta and the Kārttikeya type of Kumāragupta I seem to conform to this pattern. But a fuller analysis of this kind would require a much larger sample of coins; hopefully such expanded databases will be possible in the future. Also reserved for future research is an analysis based on Ellen Raven's grouping system. We must await publication of her long-anticipated catalogue before we can embark on that project.

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Appendix I: Detailed List of Metal Content Results, by Coin

This table reports the gold (Au), Silver (Ag) and Copper (Cu) content (as a percentage) of every coin in the sample. It was necessary to include the data from Kumar's study so that I could make clear how I had attributed his coins (since my attributions differ from his in a number of cases). The Source column specifies whether the coin is from my sample (PT) or Kumar's (SK). The ID# is my inventory number for my coins and Kumar's reported coin numbers for his. The Coin# column simply indexes the coins from 1 to 363 in numerical order; this is the order in which they appear in the scatter diagrams. Note, however, that one coin (# 341) was excluded from the analysis; its metal composition revealed it to be inauthentic.

King and Type	Source	ID #	Coin #	Au %	Ag %	Cu %	Weight
Samudragupta							
King & Queen	PT	108.20	1	96.376	3.624	0.000	7.62
King & Queen	PT	326.20	2	94.735	3.879	1.388	7.28
King & Queen	PT	438.01	3	94.525	3.961	1.514	7.77
King & Queen	PT	438.02	4	87.600	8.495	3.900	7.50
King & Queen	PT	586.08	5	88.170	8.645	3.188	7.44
King & Queen	PT	586.09	6	86.445	10.800	2.758	7.81
King & Queen	SK	1052	7	94.120	3.880	1.810	7.43
King & Queen	SK	1053	8	92.920	5.220	1.860	7.40
King & Queen	SK	1054	9	93.260	4.100	1.590	7.40
King & Queen	SK	1055	10	92.020	5.740	2.240	7.20
Archer	PT	344.25	11	88.435	8.810	2.747	7.60
Archer	PT	344.26	12	87.360	9.515	3.123	7.80
Archer	PT	531.05	13	87.160	9.715	3.125	7.15
Archer	SK	1033	14	87.180	9.900	2.320	7.55
Aśvamedha	SK	1039	15	82.640	12.290	4.410	7.63
Aśvamedha	SK	1040	16	75.630	18.170	5.900	7.51
Aśvamedha	SK	1041	17	75.890	16.460	7.470	7.52
Aśvamedha	SK	1042	18	84.150	13.040	2.820	
Aśvamedha	SK	1043	19	93.230	4.770	0.400	7.98
Aśvamedha	SK	1449	20	87.110	10.170	2.410	7.72
Aśvamedha	PT	81.10	21	78.820	12.390	8.790	7.60
Aśvamedha	PT	280.50	22	78.370	13.850	7.780	7.46
Aśvamedha	PT	405.60	23	77.245	15.265	7.485	7.37
Aśvamedha	PT	625.10	24	87.375	9.295	2.865	7.59
Battle Axe	PT	344.27	25	81.045	13.305	5.650	7.61
Battle Axe	PT	421.03	26	85.260	10.980	3.765	7.55
Battle Axe	PT	634.20	27	81.565	13.390	5.045	7.27
Battle Axe	PT	675.50	28	81.170	15.155	3.670	7.50
Battle Axe	SK	1044	29	79.300	13.190	7.010	7.20
Battle Axe	SK	1045	30	83.570	11.810	4.310	7.64
Battle Axe	SK	1046	31	83.600	12.080	4.140	7.30
Battle Axe	SK	1047	32	81.780	12.900	4.520	7.35
Battle Axe	SK	1048	33	78.020	14.170	5.570	7.41
Battle Axe	SK	1049	34	87.970	9.220	2.800	7.32
Kāca	PT	182.12	35	80.395	14.190	5.415	7.62

King and Type	Source	ID #	Coin #	Au %	Ag %	Cu %	Weight
Kāca	PT	344.28	36	83.510	12.050	4.440	7.32
Kāca	PT	468.11	37	81.905	12.910	5.190	7.27
Kāca	PT	486.21	38	86.040	10.615	3.344	7.64
Kāca	SK	1062	39	83.060	12.970	3.760	7.61
Kāca	SK	1063	40	78.240	16.470	5.170	7.50
Kāca	SK	1064	41	76.280	17.380	5.980	7.30
Kāca	SK	1065	42	83.220	12.540	3.560	7.34
Kāca	SK	1066	43	78.570	16.630	4.490	7.48
Kāca	SK	1067	44	85.440	11.030	3.160	7.79
Lyríst	PT	182.11	45	90.010	7.185	1.643	7.68
Lyríst	PT	449.04	46	87.390	9.140	3.469	7.26
Lyríst	PT	468.03	47	75.305	8.555	2.508	7.75
Lyríst	PT	468.04	48	76.080	18.135	5.785	6.50
Lyríst	PT	586.01	49	82.835	12.910	4.255	7.79
Lyríst	PT	586.02	50	82.370	12.755	4.870	7.85
Lyríst	PT	615.20	51	90.265	7.395	2.344	7.62
Lyríst	SK	1035	52	92.120	5.980	1.600	7.50
Lyríst	SK	1036	53	91.390	5.990	2.090	7.38
Lyríst	SK	1037	54	80.740	13.880	5.310	7.69
Sceptre	PT	29.20	55	85.180	11.340	3.478	7.45
Sceptre	PT	148.03	56	82.555	13.590	3.855	7.49
Sceptre	PT	419.00	57	82.785	12.625	4.590	7.73
Sceptre	PT	426.90	58	80.475	13.910	5.615	7.66
Sceptre	PT	435.10	59	82.105	13.465	4.430	7.64
Sceptre	PT	460.28	60	81.520	13.180	5.300	7.61
Sceptre	PT	460.31	61	79.690	14.960	5.350	7.62
Sceptre	PT	468.15	62	78.425	15.605	5.970	7.45
Sceptre	PT	654.54	63	82.200	13.550	4.250	7.44
Sceptre	SK	1004	64	83.600	12.400	3.490	7.85
Sceptre	SK	1005	65	80.100	14.400	4.760	7.60
Sceptre	SK	1006	66	81.530	14.490	3.980	7.40
Sceptre	SK	1008	67	82.920	12.670	3.750	7.47
Sceptre	SK	1011	68	80.380	14.430	4.870	7.43
Sceptre	SK	1012	69	83.600	12.900	3.140	7.48
Sceptre	SK	1014	70	81.500	13.400	3.650	7.60
Sceptre	SK	1015	71	83.820	12.780	3.000	7.45
Sceptre	SK	1018	72	81.680	13.140	4.650	7.43
Sceptre	SK	1019	73	86.350	10.300	3.340	7.67
Sceptre	SK	1020	74	84.480	11.280	3.930	7.56
Sceptre	SK	1022	75	80.870	12.670	5.630	7.69
Sceptre	SK	1027	76	85.360	10.720	3.050	7.43
Sceptre	SK	1030	77	87.700	9.770	2.140	7.60
Sceptre	SK	1031	78	88.660	8.580	1.500	7.50
Sceptre	SK	1034	79	81.060	11.770	6.810	7.40

King and Type	Source	ID #	Coin #	Au %	Ag %	Cu %	Weight
Sceptre	SK	1293	80	86.430	10.360	2.840	7.50
Sceptre	SK	1335	81	81.260	15.550	3.000	7.63
Sceptre	SK	1360	82	84.060	13.320	1.520	7.72
Sceptre	SK	1416	83	84.430	10.900	3.450	7.78
Sceptre	SK	1423	84	84.050	12.900	2.950	7.76
Sceptre	SK	1428	85	85.410	11.200	3.330	7.41
Sceptre	SK	1431	86	86.360	10.990	1.480	7.50
Sceptre	SK	1458	87	82.470	13.240	3.090	7.26
Sceptre	PT	p008	88	84.900	11.000	4.095	7.76
Sceptre	SK	1028	89	55.310	32.050	11.180	7.60
Sceptre	SK	1029	90	78.830	19.130	1.270	7.74
Tiger-slayer	PT	491.10	91	89.175	8.120	2.703	7.58
Tiger-slayer	SK	1057	92	88.620	7.380	3.380	7.61
Tiger-slayer	SK	1058	93	89.050	7.730	2.780	7.63
Candragupta II							
Archer-throne	PT	230.30	94	83.590	10.520	5.890	7.76
Archer-throne	PT	344.29	95	83.180	11.640	5.180	7.81
Archer-throne	PT	435.20	96	77.730	15.975	6.295	7.88
Archer-throne	PT	468.20	97	84.480	8.890	2.299	7.76
Archer-throne	PT	635.80	98	83.665	11.800	4.530	7.80
Archer-throne	SK	1071	99	83.180	12.440	4.280	7.90
Archer-throne	SK	1076	100	81.910	12.410	4.120	7.60
Archer-throne	SK	1077	101	89.660	7.950	1.660	7.78
Archer-throne	SK	1079	102	82.730	13.140	3.910	7.65
Archer-throne	SK	1445	103	79.710	12.940	3.660	7.82
Lion-slayer-throne	PT	586.07	104	83.135	11.815	5.050	7.84
Lion-slayer-throne	SK	1158	105	82.640	12.580	4.720	7.84
Lion-slayer-throne	SK	1313	106	82.390	12.090	3.920	7.72
Sceptre-throne	SK	1001	107	84.880	10.460	4.310	7.89
Sceptre-throne	PT	440.01	108	83.080	9.730	7.185	7.71
Archer-lotus	PT	87.10	109	76.215	13.715	10.075	7.13
Archer-lotus	PT	108.21	110	83.395	13.635	2.969	6.72
Archer-lotus	PT	344.30	111	81.470	11.800	6.735	7.81
Archer-lotus	PT	468.21	112	76.320	13.860	9.820	8.03
Archer-lotus	PT	468.22	113	84.155	8.710	7.140	8.18
Archer-lotus	PT	468.23	114	79.550	14.815	5.635	7.91
Archer-lotus	PT	468.24	115	83.605	11.915	4.480	7.81
Archer-lotus	PT	468.26	116	78.985	15.945	5.080	7.71
Archer-lotus	PT	468.29	117	89.335	8.095	2.573	7.90
Archer-lotus	PT	512.08	118	86.105	13.270	0.624	7.73
Archer-lotus	PT	586.10	119	81.990	12.320	5.695	7.73
Archer-lotus	PT	682.25	120	83.765	11.645	4.370	7.70
Archer-lotus	PT	687.24	121	80.940	12.995	6.065	7.74
Archer-lotus	SK	1070	122	80.530	13.700	5.450	7.78

King and Type	Source	ID #	Coin #	Au %	Ag %	Cu %	Weight
Archer-lotus	SK	1075	123	83.340	10.900	2.680	7.76
Archer-lotus	SK	1081	124	79.480	13.460	4.970	7.70
Archer-lotus	SK	1083	125	82.440	12.730	4.830	
Archer-lotus	SK	1084	126	80.150	14.100	4.420	8.10
Archer-lotus	SK	1087	127	79.080	15.330	5.270	8.10
Archer-lotus	SK	1092	128	79.220	13.530	6.860	7.70
Archer-lotus	SK	1093	129	81.070	13.790	5.140	7.56
Archer-lotus	SK	1096	130	77.280	13.370	7.550	8.00
Archer-lotus	SK	1098	131	79.070	15.890	4.560	8.20
Archer-lotus	SK	1100	132	83.200	12.280	4.240	7.86
Archer-lotus	SK	1101	133	79.590	14.120	5.020	7.80
Archer-lotus	SK	1102	134	83.270	13.190	3.470	7.78
Archer-lotus	SK	1103	135	84.550	12.100	3.080	7.72
Archer-lotus	SK	1104	136	81.500	11.530	2.290	7.90
Archer-lotus	SK	1107	137	84.180	12.320	3.410	7.80
Archer-lotus	SK	1108	138	82.690	12.130	4.920	7.70
Archer-lotus	SK	1110	139	85.670	10.580	3.100	7.60
Archer-lotus	SK	1111	140	87.930	9.120	2.820	8.03
Archer-lotus	SK	1112	141	81.730	15.140	2.790	8.10
Archer-lotus	SK	1115	142	82.220	12.610	4.480	7.66
Archer-lotus	SK	1117	143	82.600	9.060	7.900	7.80
Archer-lotus	SK	1368	144	83.680	12.320	3.210	7.84
Archer-lotus	SK	1431	145	80.100	14.720	4.780	7.87
Archer-lotus	SK	1432	146	80.230	13.400	4.370	7.95
Archer-lotus	SK	1433	147	79.320	13.980	4.600	7.88
Archer-lotus	SK	1434	148	77.890	13.690	8.220	8.18
Archer-lotus	SK	1435	149	89.090	8.530	2.300	8.10
Archer-lotus	SK	1436	150	87.770	9.700	2.240	7.81
Archer-lotus	SK	1446	151	87.780	9.490	2.310	7.81
Archer-lotus	SK	1446	152	87.140	9.970	2.400	7.81
Archer-lotus	PT	687.21	153	87.715	9.035	3.253	7.31
Archer-lotus	PT	687.22	154	83.835	11.005	5.160	7.98
Archer-lotus	PT	687.23	155	80.820	13.235	5.940	8.00
Archer-lotus	PT	691.95	156	80.035	13.705	6.260	7.91
Chatra	PT	51.30	157	81.405	12.785	5.815	7.77
Chatra	PT	108.23	158	86.615	9.690	3.695	7.71
Chatra	PT	182.14	159	85.300	11.010	3.682	7.78
Chatra	PT	230.40	160	76.890	16.120	6.990	7.74
Chatra	PT	435.40	161	82.500	12.210	5.285	7.66
Chatra	PT	435.50	162	83.235	11.675	4.215	7.68
Chatra	SK	1119	163	82.270	13.440	4.050	7.91
Chatra	SK	1120	164	82.890	11.530	4.340	7.63
Chatra	SK	1121	165	84.270	10.700	4.440	7.83
Chatra	SK	1122	166	81.530	11.790	4.570	7.78

King and Type	Source	ID #	Coin #	Au %	Ag %	Cu %	Weight
Chatra	SK	1124	167	81.990	12.060	4.270	7.60
Chatra	SK	1125	168	80.620	14.550	4.840	7.72
Chatra	SK	1128	169	79.660	15.890	4.100	7.85
Chatra	SK	1130	170	81.230	13.870	4.570	7.85
Chatra	SK	1133	171	81.970	11.860	4.030	8.10
Couch	PT	703.00	172	79.550	13.270	6.675	7.63
Couch	SK	1150	173	84.770	11.450	3.520	7.69
Couch	SK	1002	174	82.200	14.100	3.430	7.33
Couch	SK	1003	175	87.910	8.890	3.070	7.68
Horseman	SK	1135	176	90.160	7.730	1.840	7.86
Horseman	SK	1136	177	80.140	14.110	4.540	7.75
Horseman	SK	1139	178	80.570	13.600	5.480	7.50
Horseman	SK	1141	179	82.680	12.240	4.420	7.60
Horseman	SK	1142	180	82.580	9.810	3.420	7.40
Horseman	SK	1143	181	82.360	11.610	4.050	7.74
Horseman	SK	1144	182	83.230	12.690	3.980	7.75
Horseman	SK	1145	183	87.980	9.350	2.280	7.68
Horseman	SK	1146	184	82.180	12.400	5.330	7.72
Horseman	SK	1147	185	76.750	13.000	8.110	7.71
Horseman	SK	1437	186	75.580	18.780	5.220	8.23
Horseman	SK	1439	187	84.710	11.740	3.070	7.70
Horseman	SK	1134/1438	188	83.900	9.090	3.100	7.86
Horseman	PT	108.22	189	78.185	15.540	6.275	7.79
Horseman	PT	468.08	190	85.265	10.690	4.045	7.80
Horseman	PT	503.19	191	84.975	11.395	3.631	7.61
Horseman	PT	586.04	192	82.310	12.265	5.415	7.89
Horseman	PT	586.12	193	82.425	11.465	6.110	7.93
Horseman	PT	148.04	194	81.010	12.325	6.665	7.77
Horseman	PT	491.20	195	83.155	12.500	4.345	7.96
Horseman	PT	564.22	196	84.655	11.160	4.180	7.61
Horseman	PT	586.13	197	84.440	11.865	3.695	7.78
Horseman	PT	591.03	198	82.765	12.290	4.945	7.79
Lion-slayer	PT	182.13	199	80.975	12.790	6.235	7.74
Lion-slayer	PT	438.03	200	81.965	13.760	4.275	7.70
Lion-slayer	PT	453.02	201	85.445	9.865	4.690	7.89
Lion-slayer	PT	468.06	202	84.215	10.685	5.100	7.85
Lion-slayer	PT	148.05	203	80.060	13.195	6.745	7.79
Lion-slayer	PT	460.29	204	83.855	11.575	4.560	7.69
Lion-slayer	PT	468.01	205	84.495	11.040	4.465	7.81
Lion-slayer	PT	468.02	206	80.340	15.555	4.105	7.86
Lion-slayer	PT	503.20	207	84.045	12.735	3.221	7.79
Lion-slayer	SK	1151	208	81.250	13.330	5.150	7.88
Lion-slayer	SK	1153	209	79.640	14.420	5.750	7.50
Lion-slayer	SK	1154	210	84.020	12.480	3.250	7.89

King and Type	Source	ID #	Coin #	Au %	Ag %	Cu %	Weight
Lion-slayer	SK	1155	211	81.130	13.800	4.600	7.71
Lion-slayer	SK	1156	212	76.700	17.100	6.040	8.13
Lion-slayer	SK	1157	213	71.850	19.990	7.890	7.86
Lion-slayer	SK	1160	214	77.980	16.690	4.880	7.70
Lion-slayer	SK	1161	215	74.100	23.610	1.760	7.61
Lion-slayer	SK	1162	216	81.210	13.430	5.200	7.82
Lion-slayer	SK	1163	217	81.360	12.700	5.500	7.79
Lion-slayer	SK	1164	218	87.000	9.710	2.910	7.83
Lion-slayer	SK	1165	219	82.260	13.700	3.870	7.92
Kumāragupta I							
Swordsman	PT	597.20	220	82.045	13.315	4.640	8.08
Apratigha	PT	394.00	222	81.080	16.005	2.917	7.90
Archer	PT	280.60	221	74.360	19.645	5.995	8.21
Archer	PT	182.16	223	76.700	17.800	5.505	7.66
Archer	PT	435.30	224	81.160	12.685	6.160	7.82
Archer	PT	486.22	225	72.390	22.220	5.385	8.17
Archer	PT	625.12	226	80.620	14.565	4.815	7.78
Archer	PT	625.13	227	80.195	12.170	7.630	7.85
Archer	PT	635.61	228	72.540	20.600	6.855	8.21
Archer	SK	1167	229	84.860	10.190	4.890	8.01
Archer	SK	1169	230	79.630	15.150	5.120	7.90
Archer	SK	1170	231	86.730	10.030	2.890	7.83
Archer	SK	1174	232	74.760	19.520	5.260	8.08
Archer	SK	1175	233	74.760	17.610	5.220	8.00
Archer	SK	1176	234	70.630	21.080	7.230	8.00
Archer	SK	1177	235	76.740	17.630	5.640	8.08
Archer	SK	1178	236	80.830	14.620	3.620	8.16
Archer	SK	1440	237	65.830	24.170	9.940	8.10
Archer	SK	1447	238	71.660	20.900	6.930	8.07
Aśvamedha	PT	700.01	239	71.245	17.255	11.495	8.28
Aśvamedha	SK	1190	240	74.660	18.000	7.120	8.28
Chattra	SK	1189	241	70.610	22.180	7.080	8.26
Elephant-rider	PT	344.34	242	70.945	17.805	8.570	8.09
Elephant-rider	PT	584.04	243	83.365	11.900	4.735	7.61
Elephant-rider	SK	1199	244	77.530	14.050	8.210	8.24
Horseman	SK	1179	245	67.880	22.010	9.840	8.17
Horseman	SK	1182	246	71.900	19.590	8.180	8.20
Horseman	SK	1184	247	76.810	16.760	5.960	8.18
Horseman	SK	1185	248	77.730	16.820	4.610	8.09
Horseman	SK	1186	249	74.450	17.670	7.660	8.18
Horseman	SK	1187	250	67.320	24.850	7.830	8.11
Horseman	SK	1188	251	69.850	25.150	4.350	7.79
Horseman	SK	1191	252	82.270	12.320	5.410	8.25
Horseman	SK	1192	253	79.840	10.580	9.500	8.20

King and Type	Source	ID #	Coin #	Au %	Ag %	Cu %	Weight
Horseman	SK	1193	254	80.010	14.540	5.360	8.29
Horseman	SK	1448	255	88.100	9.470	2.050	7.84
Horseman	PT	108.25	256	77.645	15.180	5.275	8.11
Horseman	PT	344.31	257	77.945	17.980	4.075	8.25
Horseman	PT	605.50	258	80.130	14.975	4.895	8.16
Horseman	PT	87.20	259	66.515	21.880	11.605	8.18
Horseman	PT	101.00	260	71.600	19.010	9.390	8.06
Horseman	PT	108.24	261	77.625	19.850	2.529	7.98
Horseman	PT	344.32	262	70.120	22.225	7.655	8.22
Horseman	PT	440.02	263	80.580	14.560	4.860	8.14
Horseman	PT	468.09	264	75.150	19.965	4.885	8.08
Horseman	PT	584.03	265	69.980	20.930	7.215	8.23
Horseman	PT	586.14	266	68.545	22.715	8.740	8.16
Horseman	PT	586.15	267	62.405	27.775	9.825	8.32
Horseman	PT	586.16	268	55.020	29.460	15.520	8.32
Horseman-w/Bayana clasp	SK	1181	269	77.950	17.230	4.650	10.20
Kārttikeya	PT	422.27	270	85.625	11.365	3.011	8.12
Kārttikeya	PT	591.01	271	82.835	7.725	9.445	8.27
Kārttikeya	PT	591.04	272	83.950	10.995	5.050	8.30
Lion-slayer	PT	108.26	273	71.510	22.580	5.910	7.69
Lion-slayer	PT	400.00	274	79.970	14.395	5.630	8.21
Lion-slayer	PT	591.07	275	73.520	18.280	7.730	8.27
Lion-slayer	PT	608.10	276	69.595	21.705	8.485	8.16
Lion-slayer	SK	1328	277	68.690	21.560	7.880	8.13
Lion-slayer	SK	1329	278	77.810	17.300	4.670	7.99
Lion-slayer	SK	1330	279	79.070	16.130	4.290	8.10
Lion-slayer	SK	1331	280	73.610	19.240	7.000	8.50
Lion-slayer	SK	1332	281	75.220	18.920	5.450	8.21
Lion-slayer	SK	1333	282	82.950	12.720	3.240	8.18
Lion-slayer	SK	1334	283	70.210	23.950	5.660	8.16
Lyrist	PT	701.50	284	88.075	8.845	3.082	8.11
Tiger-slayer	PT	344.33	285	79.285	15.250	5.460	8.17
Tiger-slayer	PT	619.10	286	78.385	16.520	5.100	8.07
Tiger-slayer	SK	1196	287	74.550	18.950	6.440	8.13
Tiger-slayer	SK	1198	288	74.900	18.980	5.940	
Tiger-slayer	SK	1258	289	74.590	19.510	5.800	
Tiger-slayer	SK	1259	290	71.870	20.130	7.790	
Candragupta III							
Archer-belt	PT	695.14	291	69.690	19.765	10.085	8.38
Archer-belt	PT	701.32	292	80.270	14.505	5.225	8.24
Archer-belt	PT	Hari P	293	62.995	23.850	12.660	8.23
Archer-sash	PT	468.30	294	75.680	11.825	6.475	8.22
Archer-sash	PT	663.52	295	69.060	19.235	11.705	8.14
Archer-sash	PT	702.40	296	80.490	13.420	6.090	8.27

King and Type	Source	ID #	Coin #	Au %	Ag %	Cu %	Weight
Archer-sash	PT	691.54	297	80.363	11.535	8.103	8.26
Archer-sash	PT	702.98	298	78.965	15.505	4.160	8.21
Archer-sash	SK	1082	299	82.290	8.890	8.100	8.24
Archer-sword	SK	1099	300	75.160	16.750	7.860	8.10
Archer-sword	PT	440.05	301	78.465	14.770	6.760	8.20
Archer-sun	PT	586.06	302	63.810	19.715	16.470	8.22
Archer-sun	PT	591.02	303	63.965	19.865	15.765	7.98
Archer-sun	PT	586.03	304	60.570	24.045	15.380	7.91
Archer-sun	PT	597.10	305	56.095	32.135	11.765	7.87
Archer-crescent	PT	586.05	306	81.000	16.795	2.199	8.28
Archer-crescent	PT	685.25	307	72.485	18.950	8.165	8.15
Archer-crescent	SK	1089	308	68.700	23.830	5.300	8.14
Archer-crescent	SK	1088	309	62.590	26.930	9.930	8.20
Archer-crescent	SK	1090	310	69.140	26.040	3.220	8.39
Archer-cakra	PT	687.25	311	73.270	22.330	4.405	8.64
Archer-cakra	SK	1095	312	61.590	26.310	11.090	8.46
Archer-cakra	PT	468.31	313	64.805	22.565	12.630	8.41
Archer-cakra	PT	570.00	314	62.895	21.810	15.295	7.83
Archer-cakra	SK	1094	315	70.660	23.040	2.730	8.37
Archer-altar	PT	589.01	316	76.920	18.150	4.930	8.73
Archer-altar	PT	182.17	317	76.120	18.300	5.580	8.71
Archer-altar	SK	1109	318	72.930	22.000	3.920	8.56
Archer- śrīvatsa	SK	1113	319	71.620	21.830	6.270	9.10
Horseman	PT	512.07	320	77.695	17.140	5.165	8.40
Horseman	PT	586.11	321	67.870	24.235	7.895	8.39
Skandagupta							
Archer- low weight	PT	654.50	322	72.655	22.685	4.665	8.40
Chattra - low weight	PT	591.08	323	67.020	24.285	8.695	8.41
King & Queen- low weight	PT	421.04	324	77.925	16.325	5.750	8.47
King & Queen- low weight	PT	638.91	325	77.370	15.855	6.770	7.76
King & Queen- low weight	SK	1228	326	75.360	20.520	3.940	8.58
King & Queen- low weight	SK	1229	327	77.550	18.820	3.640	8.46
Archer- heavy weight	PT	148.06	328	80.695	13.210	6.095	9.12
Archer- heavy weight	PT	148.07	329	75.985	14.750	9.265	9.07
Archer- heavy weight	PT	421.05	330	82.210	14.560	3.228	8.81
Archer- heavy weight	PT	657.85	331	84.815	11.040	3.392	9.12
Archer- heavy weight	PT	680.01	332	55.135	26.630	18.235	9.27
Archer- heavy weight	PT	696.45	333	55.285	30.555	14.160	9.09
Archer- heavy weight	SK	1221	334	75.210	15.820	8.800	9.08
Archer- heavy weight	SK	1222	335	76.680	13.870	8.820	9.16
Archer- heavy weight	SK	1223	336	79.100	15.270	5.540	9.07
Archer- heavy weight	SK	1441	337	73.270	17.040	9.580	9.00

King and Type	Source	ID #	Coin #	Au %	Ag %	Cu %	Weight
Kumāragupta II							
Archer	PT	344.35	338	75.635	15.070	9.295	9.16
Archer	SK	1239	339	79.470	13.470	7.060	9.38
Archer	SK	1238	340	77.580	13.390	8.640	9.10
Budhagupta							
Archer (excluded forgery)	PT	440.04	341	52.680	47.320	0.000	8.33
Archer	PT	597.30	342	74.685	18.970	6.345	9.23
Archer	SK	1341	343	76.060	15.690	7.070	9.34
Huns							
Prakāśāditya	SK	1235	344	81.780	12.900	4.520	9.20
Prakāśāditya	PT	468.13	345	78.305	18.430	2.769	9.34
Archer-Nameless	PT	148.08	346	73.500	15.175	11.325	9.25
Archer-Nameless	PT	148.14	347	73.515	15.600	10.885	9.31
Archer-Nameless	PT	597.40	348	77.930	14.000	8.070	9.33
Archer-Nameless	SK	1232	349	73.400	14.550	11.950	9.28
Archer-Nameless	SK	1243	350	77.270	15.780	6.630	9.38
Archer- Parākramāditya	SK	1233	351	76.410	14.060	9.430	9.46
Narasimhagupta							
Archer	PT	79.00	352	73.930	16.930	9.140	9.50
Archer	PT	512.09	353	77.935	15.015	7.050	9.51
Archer	PT	609.10	354	77.440	14.640	7.920	9.56
Archer	SK	1235	355	77.880	16.630	5.170	9.40
Archer	SK	1236	356	75.750	16.180	6.810	9.54
Archer	SK	1237	357	80.610	14.970	4.020	9.55
Kumāragupta III							
Archer	PT	440.03	358	75.385	16.130	8.485	9.21
Archer	SK	1240	359	51.880	34.520	12.970	9.63
Archer	SK	1241	360	66.370	25.380	8.000	9.48
Viṣṇugupta							
Archer	PT	462.08	361	43.620	40.240	11.715	9.12
Archer	PT	525.05	362	48.415	33.180	18.405	9.01
Archer	SK	1244	363	20.630	71.660	6.880	9.10

Note: Coin 341 was not included in the analysis because it was determined to be a forgery.