Who's wealthier? An estimation of the annual coin production of the Seleucids and the Ptolemies.

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1. Posing of the problem

In a recent article, Bert van der Spek, Peter Foldvari, and Bas van Leeuwen addressed important issues related to the changing patterns of silver with the changing prices as can be observed in Babylonia (followed by a comparative model with medieval England).[2] After convincingly establishing a relationship between the changes observed in prices and the amount of silver,[3] they used the available data to estimate "an index of the amount of silver in circulation in 383-61 BC in Babylon".[4] The framework for their methodological analysis is provided by an unobserved component in the model used to estimate how the amount of money in circulation affected the price movements. In concluding their analysis, the authors wished to test their results for silver in circulation and price movements; for doing so, they proposed two ways to check the reliability of their results: "One way is to apply the method on the data for England […]. Another way is to check whether the trend and/or fluctuations are plausible". While van der Spek *et al.* in their article follow the first method, they added as regards to the second way that "[a]n extensive long-term die study for Babylon might corroborate or falsify this scheme, but this is far beyond the scope of this chapter. In addition, even when, for example, the mint at Seleucia produced a huge number of tetradrachms, this would not imply an increase of silver in circulation in Babylonia. The money might well have been intended to pay an army that left to another region for campaigns".[5]

The last point of their statement sounded like a challenge for numismatists working on the Seleucid material. Unfortunately, we are missing a die study for the mint of Seleucia on the Tigris as well as for most of the Mesopotamian mints active during the period under consideration.[6] Nevertheless, some other methods might be of help to overcome the lack of die studies. In the following section, I will explain the nature of the database ("SHD") used for the analysis. Section 3 will determine the general framework of the method based on the largest sample of hoard data available for the

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[2] Van der Spek *et al.* 2014.

[3] Van der Spek *et al.* 2014, 489-494.

[4] Van der Spek *et al.* 2014, 494.

[5] Van der Spek *et al.* 2014, 498-499.

[6] I am actually preparing the die study for Seleucia on the Tigris from Seleucos I to Demetrios II; the results are thus far incomplete especially because of the impressive size of the mint's production under the first Seleucids.

Hellenistic world, which I will refer to as the "extrapolation method", and apply the method to estimate the annual monetized silver for the Seleucids. In section 4, I will demonstrate the validity (and use) of this method by cross checking the Seleucid results against the data for the Ptolemies; this section will also compare the relative (monetized) wealth between the two dynasties. Having established the validity of the method for calculating coins in circulation, section 5 will be devoted to analyzing the extrapolation method measures up against the results from the study by van der Spek *et al.* I will end with a brief conclusion summarizing the possibilities offered by the new method focusing on the equal importance of the economies of the Seleucids and the Ptolemies in terms of monetized metal, or by corroborating the results on the volume of silver in circulation in Babylonia obtained by different methods.

2. Introducing the database

When I started working on a project of Seleucid quantitative studies, the basic idea was to quantify data in Greek numismatics which had passed through die studies and was considered to offering the most reliable sources for quantification. Greek numismatics is obsessed with die-studies.[7] Unfortunately, die studies are missing for the major parts of the Seleucid numismatic production. For this reason, I turned towards alternative methods for estimating the relative size of issues, calculating the output of different mints, reigns, types, denominations, etc. It is important to make clear from the beginning the following methodological assumption: my analysis is concerned with the issuing dates of different regardless of their burial dates. For example, when I consider coins of Antiochos III, I calculate *all* coins produced by this king; these results are also "corrected" assuming a 1.5% annual coin loss (see a more detailed analysis below).

Roman numismatics offered an alternative to a Greek numismatic world lacking a complete record of die studies: the extrapolation from hoards or from a "master hoard" as developed by Michael Crawford.[8] The idea behind the "master hoard" is simple: gather those hoards which are representative of coin production and/or circulation in the Roman Empire. The method was criticized by Ted Buttrey, especially the size and the normalcy of the sample, but most of these criticisms were convincingly answered by François de Callatay.[9] Nevertheless, de Callataÿ stated that this method "should be a last resort" for Greek numismatics.[10] He explained that two reasons allowed for the scope of this method in the Roman world: first, and most importantly, the considerable size of Roman issues does not allow for extended die studies,[11] and second, Roman history offers a *continuum* with few changes and many

[7] See de Callataÿ 2011 for a recent *status quaestions*, where, in a rather sarcastic way, he calculated that all Greek coinages will be the subject of a die study by 2093.
[8] Crawford 1974.
[9] de Callataÿ 1995.
[10] de Callataÿ 1995 (with previous bibliography on the method; cf. esp. Crawford 1974).
[11] For the moment, only two major reigns were the subject of a complete die study: von Kaenel 1986 (Claudius) and Carradice 1987 (Domitian). Partial die studies are published, like those for the *cistophori* of Augustus or the restored coinage of Trajan.

hoards. Interestingly enough, these conditions are present for the Seleucids as well: large issues and relatively unified history.[12]

The challenge when considering Seleucid production was to create a reliable database where absolute numbers of coins by mints, reigns, regions etc. could be used as representative of the original volume of production. For this purpose, I created the "SHD", the "Seleucid Hoard Database".[13] As the name indicates, this database contains all hoards with Seleucid coins (even hoards with a single Seleucid coin are included). In some of these hoards, the Seleucid material constitutes a small fraction of the total content, while, in other cases, the hoard contains only Seleucid coins. These hoards were known from three major sources: the "Inventory of Greek Coin Hoards" (*IGCH*), the ten volumes of "Coin Hoards" (*CH*), and the remarkable work by Arthur Houghton and Catharine Lorber in their two volumes of *Seleucid Coins* (hereafter *SC*).

The most difficult task when creating a database is to decide its type and entries. These parameters are generally determined by the objectives of the research itself. Thus, 41 different columns/entries were created, each of them reporting a different characteristic of the coin (name of the hoard, region of findspot, mint, issuing authority etc.). Since the focus of the research was quantification and coin-types, the coins of each hoard were divided by "*SC* type". This explains why two or more entries exist for the same hoard. In order to facilitate the research, the database was digitized, i.e. a unique number was attributed to every entry. I only included coins and hoards that I could verify myself (or those personally examined by the *Seleucid Coins* team) and only coins identified with certainty (this explains some differences in quantity between my data and those published in the above mentioned corpora). I collected 253 hoards, for a total of 10,203 tetradrachms, 826 drachms and smaller denominations of silver, and 1,559 bronzes. The grand total is 12,615 coins.

Limitations: Before considering the nature of the method *per se*, it is necessary to point out some of the limitations of the sample. As we have seen before, when Roman numismatists analyze collections of hoards, they apply some criteria of number. Kris Lockyear, after applying Correspondence and Cluster analysis to his material from Republican Rome, included in his study only those hoards with more than 30 coins.[14] I ran a series of tests to see what effect the inclusion or exclusion of smaller (or larger) hoards would trigger in the database. I applied the test for limits of 10, 20, 30, 40 and 50 coins. The results are given in **table 1**.

[12] For Antioch, there are some 2,247 coins from Seleucos I to Antiochos V, and 4,355 coins from Demetrios I to Philip I (more than 6,500 coins in total) in the die-studies by Le Rider 1999 (for the first part) and Houghton-Hoover-Iossif forthcoming (for the second part). In a forthcoming study, (Iossif forthcoming [b]), I calculated that some 2,820 obverse dies have been used by the Seleucids, number that equals c. 11 obverse dies per year (for a period of 248 years).
[13] Iossif forthcoming (a).
[14] Lockyear 2007.

		10		20		30		40		50	
	All hoards	<	>=	<	>=	<	>=	<	>=	<	>=
Asia Minor	1.979	50	1.929	195	1.784	297	1.682	403	1.576	478	1.501
Levante, Syria	3.805	158	3.647	396	3.409	527	3.278	671	3.134	848	2.957
Armenia	369	17	352	49	320	49	320	49	320	96	273
Babylonia, Mesopotamia, Media	1.231	39	1.192	93	1.138	197	1.034	337	894	496	735
Bactria	87	19	68	54	33	54	33	54	33	54	33
Other regions in Upper Satrapies	71	0	71	0	71	0	71	0	71	0	71
Greece	68	58	10	68	0	68	0	68	0	68	0
without provenance	2.620	5	2.615	41	2.579	66	2.554	133	2.487	133	2.487
Total	**10.230**	**346**	**9.884**	**896**	**9.334**	**1.258**	**8.972**	**1.715**	**8.515**	**2.173**	**8.057**
Asia Minor	19%	14%	20%	22%	19%	24%	19%	23%	19%	22%	19%
Levante, Syria	37%	46%	37%	44%	37%	42%	37%	39%	37%	39%	37%
Armenia	4%	5%	4%	5%	3%	4%	4%	3%	4%	4%	3%
Babylonia, Mesopotamia, Media	12%	11%	12%	10%	12%	16%	12%	20%	10%	23%	9%
Bactria	1%	5%	1%	6%	0%	4%	0%	3%	0%	2%	0%
Other regions in Upper Satrapies	1%	0%	1%	0%	1%	0%	1%	0%	1%	0%	1%
Greece	1%	17%	0%	8%	0%	5%	0%	4%	0%	3%	0%
without provenance	26%	1%	26%	5%	28%	5%	28%	8%	29%	6%	31%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 1: Test excluding smaller hoards (with less than 10, 20, 30, 40 or 50 coins) from "SHD".[15]

The exclusion of smaller hoards from the database does not affect the geographic distribution of the coins. On the other hand, it was necessary to exclude two very large hoards with a single coin type which introduced a considerable 'noise' in the results.

A second difficulty, one that we always need to keep in mind when working with this type of material, is the composition and structure of the hoard. From the 253 hoards, only 11 hoards were found in organized excavations (only 455 tetradrachms from the 10,230 recorded, i.e. 4.4%). Hoards recorded in commerce are generally incomplete but here we can overcome this difficulty based on the very systematic work done by Houghton and Lorber in this field by recording all material that appeared on the market. At the same time, there is no reason to think that the lots of published hoards (if not complete) are not representative and proportional to the original composition.

One last point of limitation: the general size of the database might seem large but these numbers are very small when compared with the Roman material. One single Roman hoard, Reka Devnia, contained almost eight times more coins than the 253 Seleucid hoards together.[16] This number, of course, is somewhat misleading since this research focuses exclusively on hoards containing Seleucid coins and I reported only for the Seleucid coins. **Table 2** below offers an "*ordre de grandeur*":

[15] This table examines the effect the exclusion of small hoards would have in their geographic distribution. A series of different tests were also performed considering their exclusion from the database. For practical reasons, these are not illustrated in this article, since they appear in Iossif forthcoming (a).

[16] Mouchmoff 1934; Depeyrot 2004.

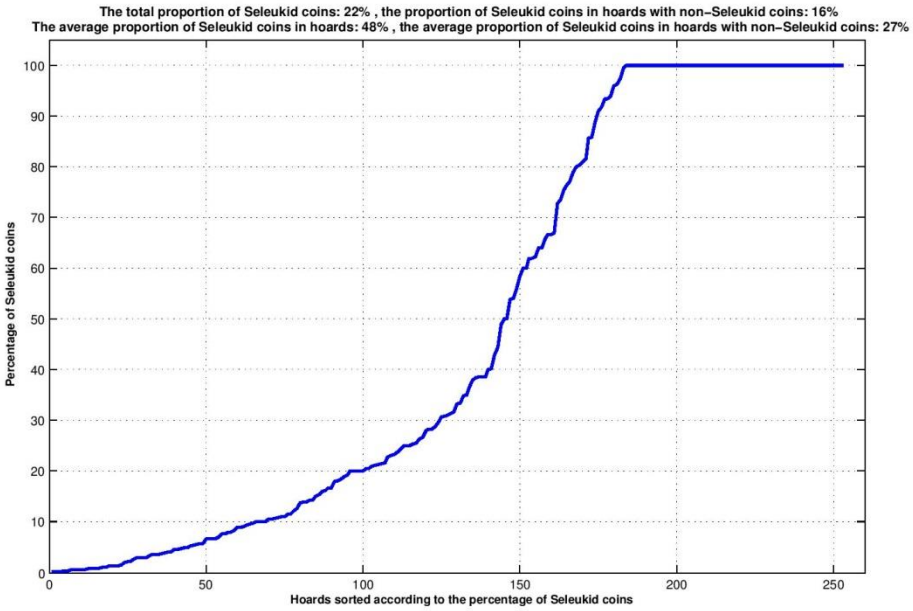

Table 2: Proportion of Seleucid coins (a) Total proportion; (b) proportion of Seleucid coins in hoards with non-Seleucid coins; (c) average proportion of Seleucid coins in hoards; (d) average proportion of Seleucid coins in hoards with non-Seleucid coins. *Source*: "SHD".

these 253 hoards contained 58,022 non-Seleucid coins in total (43,000 were tetradrachms). The percentage is 22% which drops to 16% if we consider only the mixed hoards.

3. The extrapolation method and coins in circulation

It is well known that the quality of a quantitative/statistical analysis depends solely on the quality of the sample. In a 2011 article on how to "quantify" Seleucid religion based on the "SHD", I argued that the best method for determining the relative frequency of royal coin types is the simple tabulation of as many specimens as possible known from published hoards.[17] We expect that this sample is representative of the coinage produced by royal mints and different issuing authorities. This method concerning the relative frequency of coin types based on tabulations has been used by Ian Carradice and Carlos Norena for different Roman coinages.[18] Furthermore, in Kushan coins, Robert Bracey showed a common pattern when considering relative frequencies of reverse deities on the coinages of king Huviska in hoard and die records.[19]

Nevertheless, these logical and straightforward statements were lacking in real comparative data. The question was simple: is there any other type of evidence that

[17] Iossif 2011b, 217-222.
[18] Carradice 1987; Norena 2001 and 2011.
[19] Iossif 2011b, 218-219; Bracey 2012.

could be used to test the reliability of "SHD" since a complete record of Seleucid die studies won't be available for years? The answer to this question turned out to be a crucial one and was unexpected: major collections. In a recent important article, Andrei Gândilă demonstrated that instead of biases introduced in the collection because of the preferences of curators, large collections present common patterns when compared with site finds and hoards.[20] Therefore, and following the arguments by Gândilă, it would be logical to assume that if there is a correlation to be observed between major collections and "SHD", then the reliability of "SHD" should not be questioned.[21]

Which collections? The choice was obvious for a Seleucid numismatist: the American Numismatic Society (hereafter ANS), the *Bibliothèque Nationale de France* (BNF), the British Museum (BM), Berlin and Arnold Spaer's collection. Following the same methods as with "SHD", I personally examined and reviewed all evidence from the above mentioned collections (either during my visits or online) in order to attribute them a *SC* number and correct many mistakes of attribution.

-From the ANS: 1,927 tetradrachms;
-In BNF: 1,325 tetradrachms;
-In BM: 1,066 tetradrachms;
-In Berlin: 1,128 tetradrachms;
-Spaer: 1,065 tetradrachms;

In total, 6,511 tetradrachms (and 9,533 bronzes were identified). As a last comparison point, I separated *SC* types by reign in order to add an additional reliable comparative point in the research: all coin variations were tabulated and divided by reign (and in a later stage, by types). **Table 3** reports the data as gathered by reign for the major collections compared with "SHD" and *SC* data:

[20] Gândilă 2009.
[21] It is important to point out that there are no overlaps between the contents of my database and major collections; we should expect that some (in fact quite a few) coins of the collections were originally parts of hoards but none of the recorded hoards in "SHD" ended in major collections. My second database, the "Seleucid Excavation Database" ("SED") reporting all 8,334 Seleucid coins found in 80 excavations in Asia Minor, the Near and Middle East also presents the same methodological characteristics as those observed for "SHD"; see Iossif forthcoming (a) and (c).

King	#ANS	%ANS	# SHD	%SHD	# Spaer	%Spaer	# SC	%SC	# BNF	%BNF	# BM	%BM	# Berlin	%Berlin
Seleucos I	316	16,4%	749	6,8%	73	6,8%	210	16,1%	115	8,7%	110	10,3%	96	8,5%
Antiochos I	108	5,6%	540	4,9%	45	4,2%	58	4,5%	54	4,1%	80	7,5%	80	7,1%
Antiochos II	101	5,4%	712	6,5%	35	3,3%	78	6,0%	53	4,0%	58	5,4%	39	3,5%
Antiochos Hierax	59	3,0%	145	1,3%	11	1,0%	78	6,0%	42	3,2%	19	1,8%	10	0,9%
Seleucos II	67	3,7%	738	6,7%	17	1,6%	82	6,3%	68	5,1%	30	2,8%	36	3,2%
Seleucos III	23	1,2%	131	1,2%	8	0,7%	22	1,7%	14	1,1%	11	1,0%	10	0,9%
Achaios	0	0,0%	3	0,0%	0	0,0%	1	0,1%	0	0,0%	0	0,0%	0	0,0%
Molon	0	0,0%	0	0,0%	0	0,0%	1	0,1%	0	0,0%	0	0,0%	0	0,0%
Antiochos III	199	10,4%	534	4,9%	83	8,0%	165	12,7%	109	8,2%	126	11,8%	109	9,7%
Seleucos IV	33	1,7%	180	1,6%	29	2,7%	39	3,0%	21	1,6%	22	2,1%	25	2,2%
Antiochos IV	99	5,1%	538	4,9%	46	3,8%	72	5,5%	68	5,1%	40	3,8%	50	4,4%
Antiochos V	10	0,5%	151	1,4%	10	0,9%	11	0,8%	10	0,8%	17	1,6%	11	1,0%
Timarchos	0	0,0%	0	0,0%	0	0,0%	8	0,6%	4	0,3%	2	0,2%	1	0,1%
Demetrios I	119	6,1%	900	8,2%	63	5,9%	89	6,8%	95	7,2%	74	6,9%	109	9,7%
Alexander I Balas	126	6,5%	565	5,1%	94	8,9%	39	3,0%	88	6,6%	63	5,9%	88	7,8%
Demetrios II (1st-2nd reign)	164	8,4%	1745	15,9%	125	11,7%	105	8,1%	160	12,1%	73	6,8%	111	9,8%
Antiochos VI	29	1,5%	92	0,8%	19	1,8%	20	1,5%	37	2,8%	31	2,9%	37	3,3%
Antiochos VII	144	7,4%	2099	19,1%	130	12,2%	54	4,1%	112	8,5%	76	7,1%	89	7,9%
Tryphon	13	0,7%	0	0,0%	5	0,5%	12	0,9%	14	1,1%	5	0,5%	6	0,5%
Alexander II Zabinas	22	1,1%	107	1,0%	37	3,4%	26	2,0%	39	2,9%	28	2,6%	26	2,3%
Antiochos VIII	142	7,3%	559	5,1%	129	12,7%	45	3,5%	92	6,9%	78	7,3%	99	8,8%
Antiochos IX	69	3,6%	37	0,3%	41	3,8%	41	3,1%	43	3,2%	33	3,1%	38	3,4%
Seleucos VI	20	1,0%	15	0,1%	19	1,8%	17	1,3%	18	1,4%	17	1,6%	16	1,4%
Antiochos X	7	0,4%	29	0,3%	5	0,5%	5	0,4%	10	0,8%	4	0,4%	6	0,5%
Demetrios III	5	0,3%	0	0,0%	13	1,2%	7	0,5%	13	1,0%	5	0,5%	4	0,4%
Antiochos XI	0	0,0%	3	0,0%	0	0,3%	2	0,2%	3	0,2%	2	0,2%	3	0,3%
Antiochos XII	0	0,0%	0	0,0%	0	0,0%	2	0,2%	2	0,2%	1	0,1%	0	0,0%
Antiochos XIII	3	0,2%	1	0,0%	0	0,5%	1	0,1%	3	0,2%	2	0,2%	0	0,0%
Philip I	49	2,5%	432	3,9%	28	1,9%	12	0,9%	38	2,9%	59	5,5%	29	2,6%
Total	**1.927**	**100,0%**	**11.005**	**100,0%**	**1.065**	**100,2%**	**1.302**	**100,0%**	**1.325**	**100,0%**	**1.066**	100,0%	**1.128**	100,0%

Table 3: number of coins and percentage by reign for the major collections (ANS, BNF, BM, Berlin, Spaer) and "SHD" and *SC*. *Source*: Iossif forthcoming (a).

The percentages are illustrated in **figure 1**:

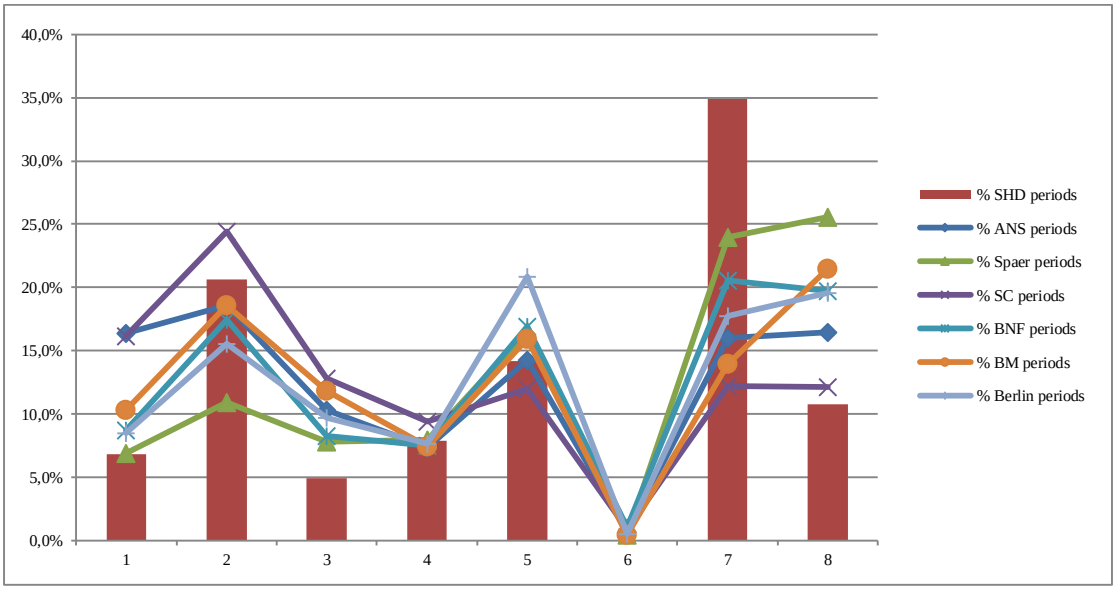

Figure 1: tetradrachms reported from different collections. For practical reasons of illustration, the data is divided by larger periods 1 to 8 (1: Seleucos I; 2: Antiochos I to Seleucos III; 3: Antiochos III (Achaios & Molon); 4: Seleucos IV to Antiochos V; 5: Demetrios I to Antiochos VI; 6: Diodotos Tryphon; 7. Demetrios II first reign to Demetrios II second reign; 8. Antiochos VIII to the end of the Seleucids). *Source*: Iossif forthcoming (a).

From figure 1, it is clear that a common pattern of distribution can be observed from six random (and independently created) datasets. Some minor differences are to be observed, but they mostly concern the locally biased private collection created by Arnold Spaer.[22] It is therefore possible to argue that the "SHD" can be considered as a random and reliable database for further analyses.

[22] Iossif forthcoming (a) for further analysis on these datasets and results.

For the purposes of the present article, it is also possible to test the reliability of "SHD" in one additional way. This test concerns the possible correlation between absolute numbers of coins observed in "SHD" with observe dies known from larger die studies. In practice, we compared the relative percentages of coins by reign (or by mint) in "SHD" with dies of the same kings (and/or mints) in published die studies. If a pattern is observed between number of coins in "SHD" and produced dies, then all conclusions based on "SHD" could be quantified in terms of original production and volume of production.

Two die studies are available for major mints of the Seleucids: that of Georges Le Rider for Antioch and a second one for Ecbatana by Pierre-Yves Boillet.[23] Antioch and Ecbatana will serve as test points for examining the possible correlation between the relative proportion of coins in "SHD" and estimated dies.[24] **Table 4** reports the Antiochene tetradrachms in "SHD" divided by "issuing authority", i.e. by reign. Those coins are compared in a second column with the number of "estimated" dies from the same mint:

Reign	# of ANT coins in SHD	# of estimated dies in *Antioche*	Coin loss ANT (1,5%)
Seleucos I	**10**	**10**	**21,8**
Antiochos I	**13**	**4**	**27,5**
Antiochos II	**40**	**6**	**70,1**
Seleucos II	**118**	**28**	**162,8**
Seleucos III	**91**	**6**	**117,9**
Antiochos III	**139**	**60**	**221,5**
Seleucos IV	**61**	**24**	**86,2**
Antiochos IV	**267**	**63**	**363,5**
Antiochos V	**122**	**22**	**155,3**
Demetrios I	**533**	**199**	**685,3**
Alexander I Balas	**194**	**69**	**225,7**
Demetrios II	**102**	**37**	**115,8**

Table 4: Comparison of absolute coins in "SHD" and dies in *Antioche*. *Source*: Iossif forthcoming (a) and Le Rider 1999.

The third column corrects the number of coins assuming a 1.5% annual coin loss.[25] This table examines the trend and not the level (the same goes for the following tables as well) which is illustrated in **Figures 2** and **3**:

[23] Le Rider 1999; Boillet 2009.

[24] For the purposes of this analysis, I refer to "estimated" instead of "observed" dies. In order to calculate the original "estimated" number of dies, I use Esty's 2006 formula.

[25] The formula applied to calculate the 1.5% coin loss is: n*(1+a)^t, where n=number of observed coins; a=% of coin loss; t=time between issue and burial. The 1.5% is inspired by Aperghis 2004, 229 (with reference to de Callataÿ 1995, 303-304), where he assumes a c. 2% annual replacement (therefore coin loss). This percentage seems quite high to me, even if a ratio up to 3% was proposed by Aperghis, so I assume a slightly lower percentage. For this analysis, it is important to assume a common coin loss percentage (the level can be discussed). Special thanks to Bas van Leeuwen for the long discussions on the question and for correcting the formula.

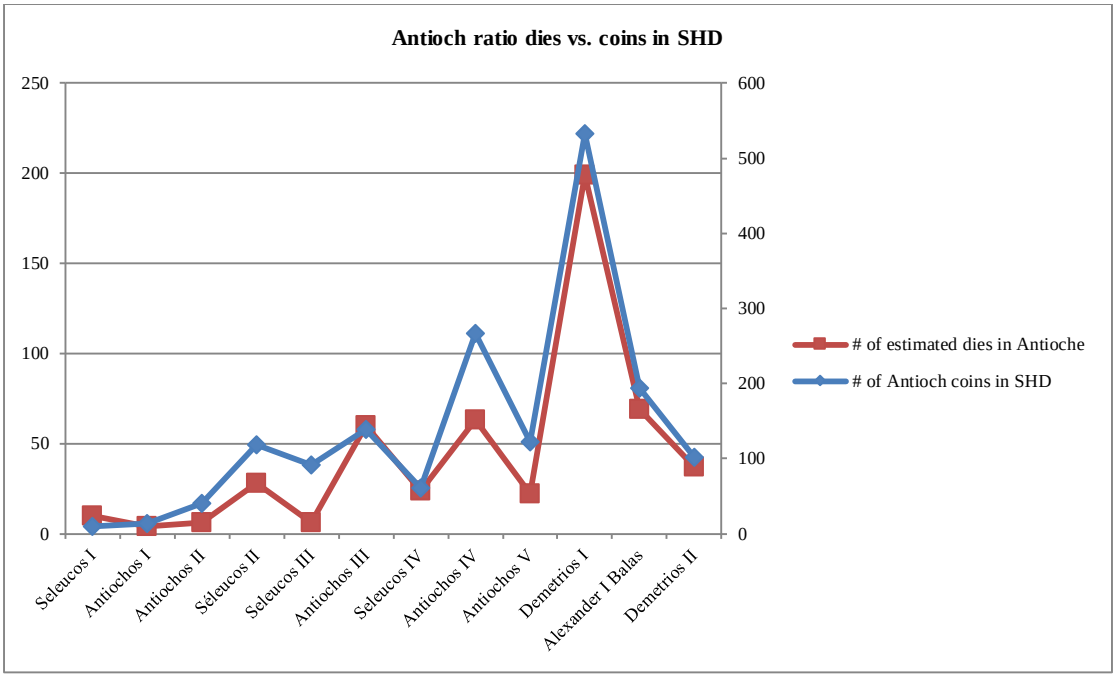

Figure 2: Antioch: number of tetradrachms in "SHD" vs. estimated dies. *Source*: Iossif forthcoming (a) and Le Rider 1999.

The same data are compared to those assuming a 1.5% annual coin loss in **figure 3** and, as can be seen, the illustrated pattern follows that of the absolute number of coins observed in "SHD":[26]

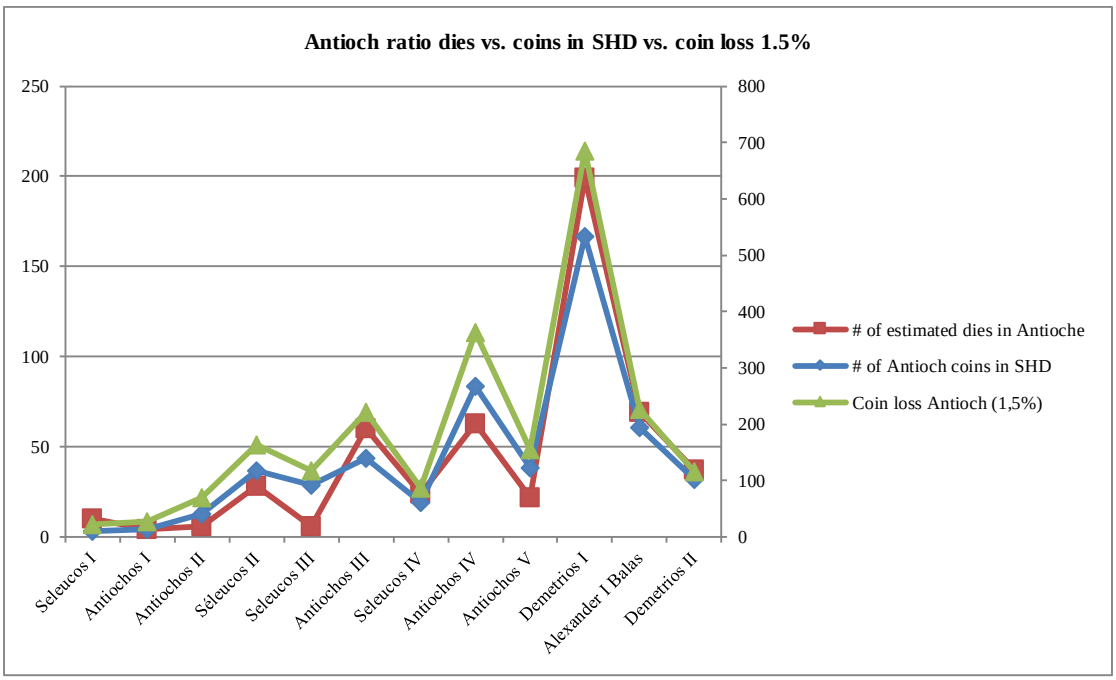

Figure 3: Antioch: number of tetradrachms in "SHD" vs. estimated dies vs. coins with 1.5% coin loss. *Source*: forthcoming (a) and Le Rider 1999.

[26] Coin loss is calculated (and illustrated) for the following analyses as well, but it is not developed in the analysis since it affects little (or none) the pattern we get from observed coins in "SHD". It is illustrated as a comparison point used to strengthen (and confirm) the results from "SHD".

The patterns in figures 2 and 3 demonstrate a straightforward correlation between the absolute number of tetradrachms in "SHD" and the estimated number of dies in Le Rider's excellent die study. If this observation is correct, it has some important implications: it means that the relative proportion of coins represented in the hoard data is directly related to the original number of dies, therefore making our sample representative of the original volume of production of Antioch.

The same approach has been done for another major (but smaller than Antioch) mint: Ecbatana. In **table 5** I give the data for Ecbatana; the tetradrachms found in "SHD" are separated by reign.

Reign	# of Ecb coins in SHD	Dies estimated by Boillet	Coin loss Ecb (1,5%)
Seleucos I	**64**	**61**	**114,9**
Antiochos I	**12**	**10**	**24,4**
Antiochos II	**6**	**3**	**15,2**
Seleucos II	**17**	**4**	**20,9**
Seleucos III	**0**	**2**	**0,0**
Antiochos III	**9**	**52**	**13,8**
Seleucos IV	**0**	**5**	**0,0**
Antiochos IV	**4**	**9**	**6,4**
Antiochos V	**0**	**0**	**0,0**
Demetrios I	**8**	**15**	**10,3**
Alexander I Balas	**1**	**1**	**1,1**
Demetrios II	**0**	**0**	**0,0**

Table 5: Comparison of absolute coins in "SHD" and dies in Boillet 2009. *Source*: Iossif forthcoming (a) and Boillet 2009.[27]

As for Antioch, these data are illustrated in **figure 4**:

[27] Here too, as for table 4, the focus of the analysis is to determine a trend and not a level.

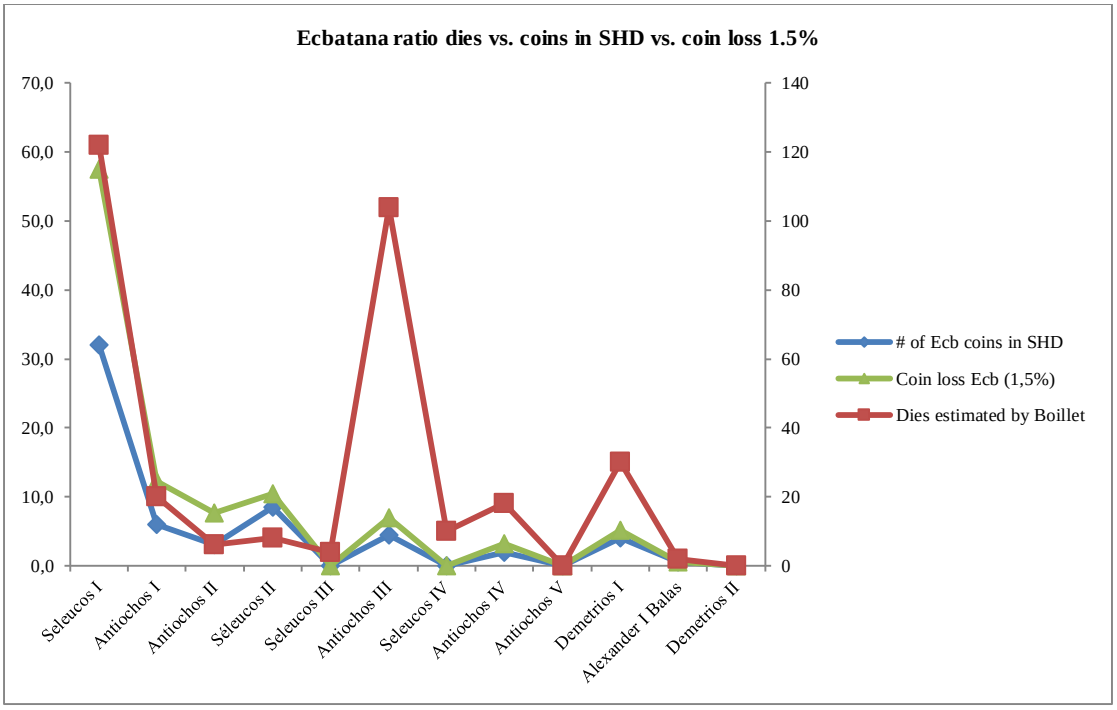

Figure 3: Ecbatana: number of tetradrachms in "SHD" vs. estimated dies vs. coins with 1.5% coin loss. *Source*: Iossif forthcoming (a) and Boillet 2009.

The correlation for Ecbatana is also positive, although some differences in the pattern are to be observed, especially for the reign of Antiochos III. The case of Ecbatana shows that the correlation "absolute coins vs. estimated dies" is sensitive when it concerns smaller mints and when the ratio n/d in the die studies is too low (for Antiochos III, the n/d=1.6 with n=43 and d=26).[28] The results from Antioch and the larger reigns show that the method is more reliable when it deals with larger mints and reigns (cf. Seleucos I at Ecbatana), but remains sensitive to statistical noise when it comes to smaller mints and relatively low-producing reigns.

Even if the method presents slight divergences for smaller mints, this doesn't affect the overall result since Antioch (along with Seleucia on the Tigris) produced the larger part of Seleucid issues. The percentage of Antioch as part of the overall Seleucid production can be calculated with precision using "SHD". For the period from the reign of Seleucos I to the end of the dynasty 3,905 tetradrachms are from Antioch (38.2%). For the period from its opening to the reign of Antiochos VII, when the second major mint of Seleucia on the Tigris was definitively lost to the Seleucids, 3,240 tetradrachms are reported from Antioch *contra* 1,207 from Seleucia (35,9 vs. 13,4%). This means that about half of the coins produced until the reign of Antiochos VII were minted in Antioch and Seleucia, and Antioch represented 2 out of 5 coins ever produced by the Seleucids.[29]

[28] Boillet 2009, 967-972.
[29] Antioch and Seleucia, together with Ecbatana, Susa, and Sardis produced the greater part of the Seleucid issues, for some periods covering more than 90% of the total production (cf. below).

Therefore, if the extrapolation method proves to be reliable, the relative ratio of coins in "SHD" could also represent the ratio of the original number of dies issued by the different mints, especially by the larger among them. Thus far, I tested the method using the data from "SHD" and known die studies. The question remains how to extrapolate for mints with die studies yet to be written, i.e. for Seleucia on the Tigris. I propose the following method. First, the known data: Seleucia is represented by 1,204 tetradrachms in "SHD" from Seleucos I to Demetrios II, first reign. We also know the ratio of Antiochene coins to those of Seleucia. **Table 6** summarized the known data for Seleucia on the Tigris:

Reign	# of SoT coins in SHD	Coin loss SoT (1,5%)	Ratio of SoT to Ant coins in SHD
Seleucos I	**276**	**466,1**	**27,6**
Antiochos I	**289**	**769,7**	**22,2**
Antiochos II	**402**	**1318,2**	**10,1**
Seleucos II	**52**	**64,3**	**0,4**
Seleucos III	**17**	**37,6**	**0,2**
Antiochos III	**65**	**197,0**	**0,5**
Seleucos IV	**10**	**17,9**	**0,2**
Antiochos IV	**16**	**26,1**	**0,1**
Antiochos V	**0**	**0,0**	**0,0**
Demetrios I	**10**	**12,9**	**0,0**
Alexander I Balas	**32**	**37,2**	**0,2**
Demetrios II	**35**	**37,4**	**0,3**

Table 6: "SHD" data for Seleucia on the Tigris. *Source*: Iossif forthcoming (a).

We also know the relative ratio of tetradrachms from Antioch and Seleucia which is 1.4:1 (1,690 vs. 1,204 tetradrachms from Seleucos I to Demetrios II first reign). Therefore, if Antioch produced 528 dies for the period under consideration, then Seleucia should have produced some 377 obverse dies. Pushing the evidence a step further, these 528+377 dies from the two major mints represent about 50% of the total production which can be estimated for almost 1,800 obverse dies for the period from Seleucos I to Demetrios II.

Georges Le Rider and François de Callataÿ used a comparable approach in order to estimate the quantity of monetized silver in circulation between c. 300 and c. 240-235 BC.[30] The basis for their analysis was the large hoard found at Meydancıkkale, Turkey.[31] Why Meydancıkkale? Le Rider and de Callataÿ correctly argue that this hoard presented favorable conditions for such analysis: it was found during a scientific excavation (therefore, there are no doubts about its integrity) and it was a large hoard.[32] The hoard contained 252 Seleucid tetradrachms, of which 21 were from

[30] Le Rider and de Callataÿ 2006, 226-228. It is interesting to note that de Callataÿ 1995 qualified this method as "a last resort"; the fact he used it in his 2006 monograph co-authored with Georges Le Rider marks a change in the way to appreciate the method by two of the most important numismatists of the last two generations.
[31] Davesne and Le Rider 1989.
[32] Le Rider and de Callataÿ 2006, 226.

Antioch. A surprising error of calculation drives Le Rider and de Callataÿ to a miscalculation: they assume that the Antiochene lot represents 9.4% (rounded up to 10%) when, in fact, it stands for 8.3% (and should be rounded down to 8%).[33] Therefore, following the authors' analysis, 10% of the Seleucid coinage between 300-240/235 was produced at Antioch. Thus, we know the number of obverse dies used at Antioch for the given period (c. 30); if Antioch represented 10% of the volume and produced 30 obverse dies, then c. 300 obverse dies should be used for the whole kingdom (in fact, the corrected results, based on their analysis, should be: 375 obverse dies). As a second step, they calculated the percentage of Seleucid coins as part of the non-Seleucid material of the hoard (excluding the Ptolemaic coins for obvious reasons): the Seleucid coins represented 1/7th of the coins in circulation in their realm for the given period. Pushing the evidence a little bit further, they estimated the annual monetized volume to nearly 65 talents (the correct figure should be about 80 talents).[34]

Le Rider and de Callataÿ arrived at this conclusion using a single hoard. Even if Meydancıkkale presented some optimal conditions, it suffered from biases since it only recorded data for a given area excluding, therefore, important parts of the production. Using "SHD" to choose those hoards with a comparable burial date, we get a larger and more representative sample of 38 hoards. The following **tables 7-9** give the data for the analysis:

38 hoards with "Period of burial from >= 235 BC"

Seleucid tetradrachms	772
Seleucid drachms	59
Seleucid "tetradrachm-value" coins	786
Seleucid AEs	375
Total tetradrachms	9.233
Total drachms	4.597
Total Seleucid "tetradrachm-value" coins	10.382
Total AEs	399
Percentage of Seleucid tetradrachms	8,4%
Percentage of Seleucid drachms	1,3%
Percentage of Seleucid "tetradrachm-value" coins	7,6%
Percentage of Seleucid bronzes	94,0%

Table 7: Data for the 38 hoards. Nos. of hoards: 36 hoards (nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 154, 155, 163, 164, 165, 166, 190, 191, 192, 193, 194, 208, 249). *Source*: Iossif forthcoming (a).

Antioch mint in the 38 hoards

Seleucid tetradrachms	24
Seleucid drachms	0
Seleucid "tetradrachm-value" coins	24

[33] Le Rider and de Callataÿ 2006, 226.
[34] Le Rider and de Callataÿ 2006, 227-228.

Seleucid AEs	54
Number of tetradrachm dies	30
Percentage of Antioch tetradrachms	3%
Estimated no. of all Seleucid dies for tetradrachms	964
Average production of silver coins per die	20.000
Average production of silver talents per die	13,3
Production of Seleucid tetradrachms per year (talents)	195
Production of Seleucid tetradrachms per year (tons)	5,1
Percentage of drachms in silver production	2%
Production of Seleucid silver coins per year (talents)	**198**
Production of Seleucid silver coins per year (tons)	**5,2**
Production of all circulated silver per year (talents)	**2.621**
Production of all circulated silver per year (tons)	**68,1**

Table 8: Data for Antioch in the 38 hoards. Nos. of hoards: 36 hoards (nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 154, 155, 163, 164, 165, 166, 190, 191, 192, 193, 194, 208, 249). *Source*: Iossif forthcoming (a).

Ecbatana mint in the 38 hoards

Seleucid tetradrachms	58
Seleucid drachms	2
Seleucid "tetradrachm-value" coins	59
Seleucid AEs	0
Number of tetradrachm dies	62
Percentage of Ecbatana tetradrachms	8%
Estimated no. of all Seleucid dies for tetradrachms	825
Average production of silver coins per die	20.000
Average production of silver talents per die	13,3
Production of Seleucid tetradrachms per year (talents)	167
Production of Seleucid tetradrachms per year (tons)	4,3
Percentage of drachms in silver production	2%
Production of Seleucid silver coins per year (talents)	**170**
Production of Seleucid silver coins per year (tons)	**4,4**
Production of all circulated silver per year (talents)	**2.241**
Production of all circulated silver per year (tons)	**58,3**

Table 9: Data for Ecbatana in the 38 hoards. Nos. of hoards: 36 hoards (nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 154, 155, 163, 164, 165, 166, 190, 191, 192, 193, 194, 208, 249). *Source*: Iossif forthcoming (a).

Antioch mint & Ecbatana mint in the 38 hoards

Seleucid tetradrachms	82
Seleucid drachms	2
Seleucid "tetradrachm-value" coins	83
Seleucid AEs	54
Number of tetradrachm dies	92

Percentage of tetradrachms	11%
Estimated no. of all Seleucid dies for tetradrachms	866
Average production of silver coins per die	20.000
Average production of silver talents per die	13,3
Production of Seleucid tetradrachms per year (talents)	175
Production of Seleucid tetradrachms per year (tons)	4,5
Percentage of drachms in silver production	2%
Production of Seleucid silver coins per year (talents)	**178**
Production of Seleucid silver coins per year (tons)	**4,6**
Production of all circulated silver per year (talents)	**2.352**
Production of all circulated silver per year (tons)	**61,1**

Table 10: Data for Antioch and Ecbatana as a whole in the 38 hoards. Nos. of hoards: 36 hoards (nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 154, 155, 163, 164, 165, 166, 190, 191, 192, 193, 194, 208, 249). *Source*: Iossif forthcoming (a).

Applying the "Meydancıkkale method" to a larger and extended sample (both geographically and chronologically), it is possible to estimate the annual production of the Seleucids to c. 180 talents per year between c. 300 to c. 240-235 BC., a number the significantly differs from the c. 80 talents per year based on the Meydancıkkale hoard.

It is well known that the Seleucid economy was an "open" one. This model was the *topos* of the Hellenistic world (with notable exceptions like the Ptolemies discussed below) where coins of the same standard could freely circulate within the borders of the realm. Therefore, we have a few mixed hoards or even hoards found within the Seleucid kingdom containing no coins issued by the royal authority. In order to evaluate and estimate the volume of Seleucid coins in circulation (and the volume of coins produced), it is necessary to calculate the percentage of Seleucid coins as compared with other Attic-weight coins. The "SHD" proves to be the perfect tool for such analysis. By choosing only the mixed hoards, we get the following picture:

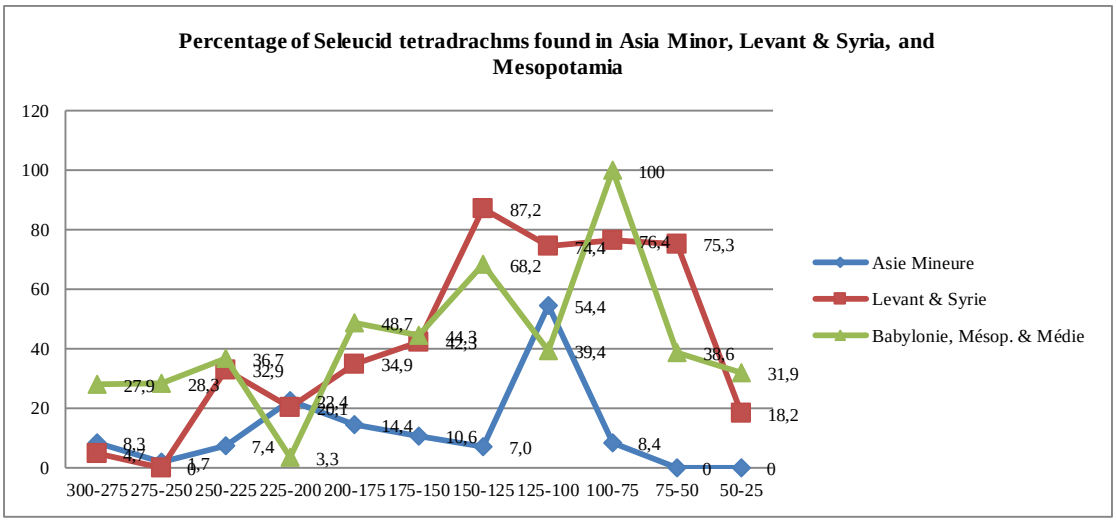

Figure 4: Percentage of Seleucid tetradrachms found in AM, L&S, and Mesopotamia. *Source*: Iossif forthcoming (a).

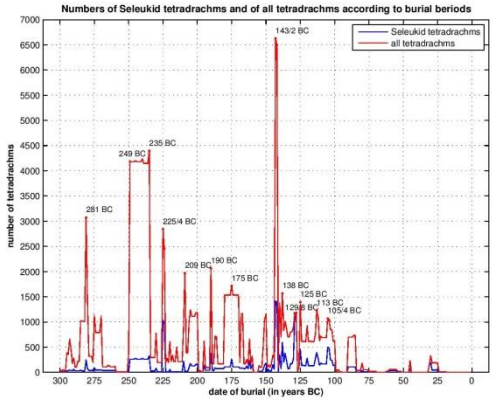

Figure 5: Percentage of Seleucid tetradrachms found in AM, L&S, and Mesopotamia in a 25-year moving window. *Source*: Iossif forthcoming (a).

The analysis of the "SHD" shows that in the long run, almost one out of five coins in circulation within the Seleucid kingdom was produced by the Seleucids. Of course, nuances are to be considered since I only calculated mixed hoards and also covered regions which were no more parts of the real authority of the kings (e.g. Asia Minor after 190 BC.). Following the conclusions from the "SHD" extrapolations for the annual production of the Seleucids, we can estimate that the total volume of coins circulating in the kingdom per year (following the 1:5 ratio of Seleucid to non-Seleucid coins) was of: 5*180=900 talents.

The data from the above analysis (and for significant benchmark years that will be used below) are summarized in the following table:

Period	# of hoards in SHD	# Seleucid tetradrachms	# non-Seleucid tetradrachms	Total number of tetradrachms	Talents per year
300-240/235	38	772	9,233	10,005	178
204-75 (including Asia Minor and Baktria)	158	6,442	13,414	19,856	185
204-75 (without Asia Minor and Baktria)	121	6,335	11210	17,565	185

Table 11: Benchmark periods of the Seleucid analysis (covering periods discussed in this article). Number of hoards, Seleucid tetradrachms, and non-Seleucid tetradrachms used to estimate the annual monetized talents. *Source*: Iossif forthcoming (a).[35]

4. Cross checking a method (I): die studies for the Ptolemies

This estimation, as that by Le Rider and de Callataÿ, stands as very low when considered against the literary evidence reporting on the fabulous wealth of the Seleucids. In order to test once more the reliability of the result (and of the method), it was necessary to compare the result against the wealth of the rival dynasty of the Ptolemies, reportedly as rich, if not richer, than the Seleucids and, at the same time, cross check the relative validity of the results from the extrapolation method. My approach to the Ptolemaic data varies from that of the Seleucids: we have poor hoard evidence but a complete die study for the period covering the years 204 to 81 BC.[36] There is an artificial separation starting with the reign of Ptolemy V and ending with the death of Ptolemy IX. This division is the result of the current state of research. In 2012 Julien Olivier completed the larger Ptolemaic die-study covering c. 6,400 gold and silver coins.[37] The reasons he chose this chronological framework were dictated by the nature of the research (a PhD thesis) but also was presented on solid historical grounds: around 200, the Ptolemies lost almost all overseas territories, with the exception of Cyprus and the southern part of Coele-Syria, and they needed to calibrate their policy to the new conditions and also to the presence of the new rising power in Eastern Mediterranean, i.e. Rome. The second century is also characterized by two important events: *primo*, a series of "national" Egyptian revolts, especially in Upper Egypt, and *secundo*, the numerous dynastic conflicts opposing different branches of the dynasty.[38]

Whatever the reasons and accuracy of this arbitrary division of Ptolemaic history, Olivier offers an invaluable tool for accessing the Ptolemaic monetary economy, a unique snapshot of the whole second century. For the Seleucids, I estimated the annual amount of monetized metal based on the "SHD" and extrapolated die data from Antioch. For the Ptolemies, the same approach can be done based on the extensive die data.

Contrary to the Seleucids, the Ptolemies produced extensive series of gold coins in two denominations: the heaviest was the *mnaieion* and the lighter was the *pentekontadrachmon*. This fact adds a new factor in our analysis: the ratio between gold and silver. Since the Seleucids produced silver coins as nearly 95% of their

[35] The exclusion of Asia Minor and Baktria doesn't really affect the overall results, since both regions escaped Seleucid control a few years *after* the 204 BC chronological limit set for this research (190/89 for Asia Minor; middle of the 2nd c. BC for Baktria; cf. Capdetrey 2007, 253-254 for the status of this region under Antiochos III; *contra* Sherwin-White and Kuhrt 1993, 107-111).
[36] The relative paucity will be compensated by two forthcoming studies: Lorber forthcoming; Faucher *et al.* forthcoming.
[37] Olivier 2012.
[38] Olivier 2012, 14-16.

production, it is necessary to convert all Ptolemaic values into Attic-silver talent values, so to compare "apples to apples".[39]

The data from Olivier's die study are the following:

Denomination	n	d	D (Esty 2006)
***Mnaieion* AV**	296	108	142 (127-159)
***Pentekontadrachma* AV**	19	4	4 (4-6)
Octadrachma	9	3	4 (3-7)
Tetradrachms	5,582	1,372	1,578 (1,546-1,610)
Didrachms	448	97	109 (102-116)
Drachms and fractions	30	15	24 (16-38)

Table 12: Estimation of the original number of dies for the Ptolemies. *Source*: Olivier 2012.

What we observe from the above table is that there is a large variety of issues spanning from silver diobols to gold *mnaieia*. As already stated, these different denominations have to be converted into a unique value, one I conventionally call the "silver-value".

An important observation from the table is that of the 6,384 coins, the overwhelming majority is issued in two denominations: *mnaieion* and tetradrachm. The *pentekontadrachme* will be converted into *mnaieion* following the ratio: 1 *mnaieion* = ½ *pentekontadrachme*. The same conversion will be applied for gold in the following ratios: 1 tetradrachm = 1/2 octodrachm = 2 didrachm. Therefore, the table for single gold and silver values is transformed in the following way:"

Denomination	n	d	D (Esty 2006)
"*Mnaieion* gold value"	304	110	144 (129-161)
"Tetradrachm silver value"	5,824	1,427	1,640 (1,608-1,672)

Table 13: Estimation of the original number of dies for the Ptolemies: converted values. *Source*: Olivier 2012.

The next step will be the transformation of these numbers into a unique value. Since the purpose of the presentation is to compare the Ptolemies to the Seleucids, I will convert gold into silver. Let's consider that each die can give 20,000 coins, as we have assumed for the Seleucids as well. This number can vary greatly from 10,000 to 40,000 coins but an agreement seems to be reached around 15,000 to 20,000 coins.[40] For the sake of our analysis, the important element is to use the same die output for all our calculations, therefore, 20,000 coins.

If we transform the (d) and (D) into coins, the table turns the following way:

Denomination	d	D
Mnaieia	110*20,000=2,200,000	144*20,000=2,880,000
Tetradrachms	1,427*20,000=28,540,000	1,640*20,000=32,800,000

Table 14: Estimation of the original number of dies for the Ptolemies: converted values in number of tetradrachms. *Source*: Olivier 2012.

[39] Ratio gold:silver=1:10.

[40] Cf. de Callataÿ 1997, 393-397; 2011, 22-23; Faucher *et al.* 2009 (c. 15,000 coins per die). Cf. also the interesting debate opposing Buttrey to de Callataÿ and give a series of articles in *NC* in the mid-90s.

Hence, we know the weight these coins represented. One *mnaieion* was comparable in weight with 8 silver drachms, c. 28 g. The tetradrachm had a weight of 13.2 g. I transform directly into kilograms:

Denomination	d	D
***Mnaieia* weight kg**	2,200,000*28 g=61,600 kg	2,880,000*28 g=80,640 kg
Tetradrachms weight kg	28,540,000*13.2 g=376,728 kg	32,800,000*13.2 g=432,960 kg

Table 15: Estimation of the original number of dies for the Ptolemies: converted values in kg. *Source*: Olivier 2012.

The conversion into Attic-talents will be based on the theoretical weight of 1 Attic talent equals 25.8 kg:

Denomination	d	D
***Mnaieia* talents**	61,600 kg/25.8=2,387 talents	80,640 kg/25.8=3,126 talents
Tetradrachms talents	376,728 kg/25.8=14,601 talents	432,960 kg/25.8=16,781 talents

Table 16: Estimation of the original number of dies for the Ptolemies: converted values in talents. *Source*: Olivier 2012.

A last step will be to convert the previous table into "silver Attic talent", the value Ancient authors used for the revenues of Hellenistic kings. We know that the ratio gold-silver for the Ptolemies was 1:13.32. Hence:

Denomination	d	D
***Mnaieia* AR talents**	2,387 *13.32=31,795 talents	3,126*13.32=41,638 talents
Tetradrachms AR talents	14,601 talents	16,781 talents
Total	**46,396 talents**	**58,419 talents**

Table 17: Estimation of the original number of dies for the Ptolemies: total talents. *Source*: Olivier 2012.

This final calculation shows that the total amount of monetized metal for a die output of 20,000 coins for the period from 204 to 81 BC. comprised between 46,396 and 58,419 talents. This study covers 123 years and we get an annual production between: 377 and 475 talents.

The two different methods used to calculate the annual production in monetized metal for the Seleucids and the Ptolemies gave about 180 talents for the former and 377 to 475 for the later. There is a slight methodological problem with a potential comparison between the two numbers: the Seleucid annual value concerns the period between 300-240/235, while the Ptolemaic is calculated for the post-204 period.

The first important element to observe is that the main concentration of hoards with Seleucid material comes from Coele-Syria, Syria, and Mesopotamia, since the removal of the lost Seleucid territories has little effect on our quantitative data. Therefore, the ratio Seleucid to non-Seleucid coins in circulation for the period under consideration as expressed in "tetradrachm value" is c. 1:2.

After determining this ratio, it is necessary to calculate mint ratios based on the extrapolation method. We previously determined that c. 53% of all coins produced by the Seleucids in the second century is from Antioch. The forthcoming die study of the

second part of Antioch gives the following results for the reigns of Antiochus III to that of Antiochus XIII (here, it is necessary to say that since 204 falls in the middle of Antiochus III' reign, all data (n and d) for this king are divided by two):[41]

N=4,823 tetradrachms (and 'tetradrachm-value' coins) from 890 obverse dies. So D (for Esty 2006) is: 970 (952-988). Following the ratio we established for Antioch, if these 970 dies correspond to 53% of the total Seleucid production, the total production for the period should have been of 1,830 obverse dies. For a die-output of 20,000 coins, we get 36,600,000 tetradrachms. For a theoretical weight of c. 17 g, the weight would have been 622,000 kg which correspond to 24,116 Attic-silver talents.

The period under consideration (204 to 75) is composed of 130 years, so the annual quantity of monetized talents is of 185 talents. The same annual amount (c. 180 talents) was estimated for the first part of the kingdom (see section **table 11** above) demonstrating a relatively stable output. Of course, this is an artificial construction since the production of coinage was not regular in Antiquity. Nevertheless, these numbers offer invaluable comparative tools without being absolute numbers: these are *des ordres de grandeur*.

The annual amount of talents minted by the Ptolemies was between 377 and 475 talents. The 185 talents for the Seleucids give the impression that the Seleucids were half as rich as the Ptolemies or, at least, they minted half coins as compared to their *frères-ennemies*. Was that the case? There was a difference in nature between the two economies: the Ptolemies had a "closed" economy where *only* their coins circulated, while the Seleucids allowed the presence of all Attic-weight coinages. We know the ratio of Seleucid coins to non-Seleucid coins in their kingdom: 1:2. This means that the 185 talents represented only one half, therefore the value of coins in circulation was of about 370 talents. That is a number very close to the lower estimate we obtained for the Ptolemies: 370 vs. 377. We have no data for the first years of the Ptolemies but we can say that these results follow the estimates proposed by de Callataÿ in that the Ptolemies used 8,000 obverse dies while the Seleucids used only 3,200 for the whole reign.[42] The difference between the two was compensated by the *libre cours*, the free circulation of other Attic-weight coinages, as demonstrated by the 1:2 ratio between Seleucid-non Seleucid coins for the post 204 period.

But what can be said for the monetization of the societies? What was the percentage of these monetized talents considered in the general framework of royal revenues? We know from different ancient sources that the Seleucids and the Ptolemies were extremely wealthy with annual revenues comprised between 10,000 to 15,000 Attic-silver talents.[43] Aperghis concluded that the revenues of the Seleucid kings varied in

[41] Houghton, Hoover, Iossif forthcoming.
[42] de Callataÿ 1993.
[43] See Le Rider and de Callataÿ 2006, 171-174 for an exhaustive list of ancient sources referring to annual revenues for the Hellenistic kings. Here, I mention a few examples of figures: Diod. 19.56.5 (11,000 talents for Antigonos the One-eyed); Justin 13.1.9 (30,000 talents for Alexander III at the time

time but a mean of 10,000 to 15,000 is also advanced.[44] Olivier, on the other hand, seems too pessimistic when considering the annual revenues of the Ptolemies between 5,000 and 10,000 talents (unfortunately without any arguments in favor of the lower numbers).[45] For the sake of the demonstration, I assume that the two dynasties had comparable revenues (a defendable position following ancient accounts) and it is worth examining the percentage of monetized talents in these figures:

	The Seleucids	The Ptolemies
Years under consideration	130	123
Talents	24,116	46,396 – 58,419
Annual revenues (a)	10,000	10,000
Annual revenues*years	1,300,000	1,230,000
% of monetized talents	**1.9%**	**3.8 – 4.7%**
2% loss per annum[46]	**5.2%**	---
1% loss per annum	**3.3%**	---
Annual revenues (b)	15,000	15,000
Annual revenues*years	1,950,000	1,845,000
% of monetized talents	**1.2%**	**2.5 – 3.2%**[47]
2% loss per annum	**3.5%**	---
1% loss per annum	**2.2%**	---

Table 18: comparative values of wealth Seleucids vs. Ptolemies and ratio of monetization. *Sources*: Iossif forthcoming (a) and Olivier 2012.

In all cases, we see that the monetized wealth in both dynasties represent a really tiny percentage, never above 5% (slightly above this limit when assuming a 2% loss per annum in the case of annual revenues of 10,000). This doesn't mean that this limit wasn't crossed on one or more occasions since coins weren't regularly produced and their primary purpose was to cover military expenditures; innumerable Seleucid and Ptolemaic coinages, especially those of the larger denominations can be related to military events. Recently Olivier and Lorber published an article on the gold issues of the first Ptolemies, where most of these issues were related to the payment of donatives to retiring veterans.[48] A quick look on a map plotting the Seleucid hoards shows a clear concentration of a large majority in the Coele-Syrian area, the main theater of the numerous Syrian Wars.

To conclude this section, we can assume the following two conclusions: *primo*, the two dynasties were of equal wealth issuing (or allowing the circulation of) a more or less comparable amount of talents per year. *Secundo*, the level of monetization of these economies was significantly low with a monetization rate well below 5% of the

of his death);Jerome, *In Dan.* 11.5 (the annual revenues of Ptolemy II are calculated to 14,500 silver talents).

[44] Aperghis 2004, 249-261. These two figures are also proposed by Le Rider and de Callataÿ 2006, 175.

[45] Olivier 2012, 877.

[46] For the 2% annual coin loss see above and Aperghis 2004. I estimate this rate as being too high; for this reason, a second calculation of 1% annual loss is also assumed and calculated in order to provide maxima and minima ranges for the calculations.

[47] Olivier 2012, 888 arrives at larger percentages comprised between 3 to 10% mostly because he chose to estimate the annual revenues of the Ptolemies somewhere between 5,000 and 10,000 talents.

[48] Olivier and Lorber 2013.

annual revenues for both dynasties. This fits well with the arguments defended by de Callataÿ assuming a considerable part of the transactions were taking place in kind.[49]

5. Cross checking a method (II): Silver fluctuations in Babylonia and Mesopotamia

At the beginning of this article, I referred to the recent study by van der Spek *et al.* estimating the quantity of silver in circulation in Babylonia. If we accept that the extrapolation method based on the "SHD" can compensate the lack for die studies, it is worth examining if the data we get corroborates what is estimated by the three authors and move from the Empire-wide analysis of the previous sections, to the specific and local focusing on Mesopotamia.

Table 10 summarizes the evidence for those hoards found in Mesopotamia:

	Asia Minor	Levant & Syria	Mesopotamia	Total	% Asia Minor	% Levant & Syri	% Mesopotamia
300-291	0	0	14	14	0,0%	0,0%	100,0%
290-281	0	0	10	10	0,0%	0,0%	100,0%
280-271	0	1	74	75	0,0%	1,3%	98,7%
240-231	5	5	25	35	14,3%	14,3%	71,4%
230-221	3	3	23	29	10,3%	10,3%	79,3%
210-201	2	6	41	49	4,1%	12,2%	83,7%
200-191	6	10	23	39	15,4%	25,6%	59,0%
190-181	5	14	37	56	8,9%	25,0%	66,1%
180-171	5	24	27	56	8,9%	42,9%	48,2%
160-151	0	17	0	17	0,0%	100,0%	0,0%
150-141	0	73	4	77	0,0%	94,8%	5,2%
140-131	6	315	222	543	1,1%	58,0%	40,9%
110-101	0	27	0	27	0,0%	100,0%	0,0%
100-91	0	1	0	1	0,0%	100,0%	0,0%
80-71	0	40	0	40	0,0%	100,0%	0,0%
60-51	0	31	0	31	0,0%	100,0%	0,0%
Total	**32**	**567**	**500**	**1099**	**2,9%**	**51,6%**	**45,5%**

Table 19: Hoards found in Mesopotamia analyzed by decade. *Source*: Iossif forthcoming (a).

The 45 hoards in the database contain 1,099 Seleucid and 2,119 non-Seleucid tetradrachms (again, it should be noted that *only* hoards with Seleucid material are included in this analysis).[50] The data are tabulated in chronological order by decade and also by provenance. What sorts out from the analysis is that from 300 to 180-171, the coins found in the area are clearly of local origin; the decade 180-171 is transitional since the coins produced in the Levant and Syria are almost equal to those produced by local mints (48.2% vs. 42.9%). After that date, the Levantine productions take the lead marking the unquestionable primacy of Antioch.

[49] de Callataÿ 2006.
[50] Nos. 163-207 in "SHD".

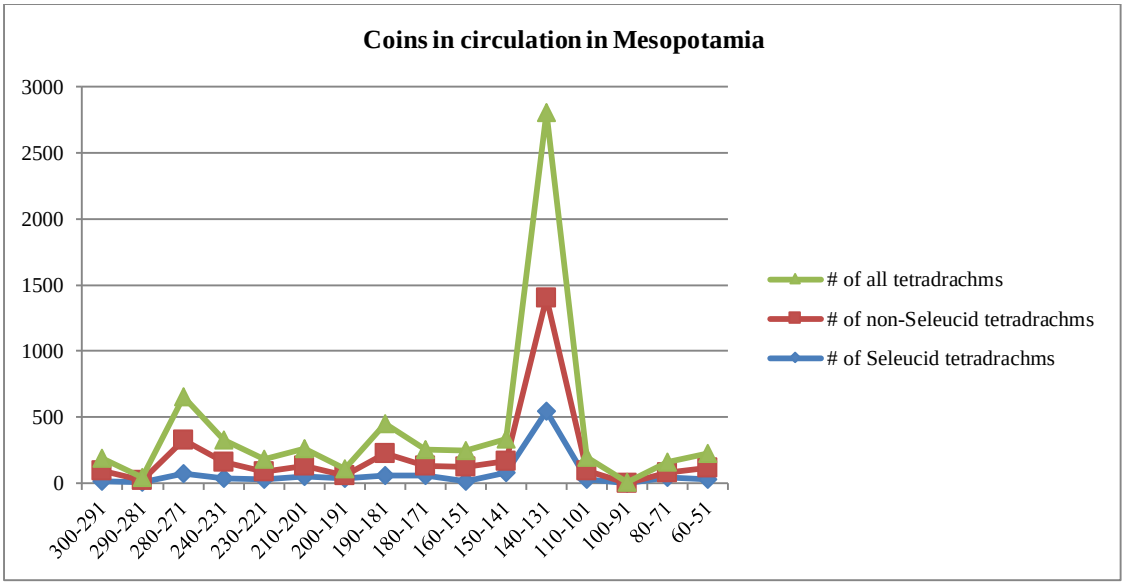

Figure 6: Fluctuation of tetradrachms in circulation in Mesopotamia. *Source*: Iossif forthcoming (a).

Van der Spek *et al.* observed some important peaks in the quantity of silver in circulation: at the beginning of the Hellenistic period related to the monetization of the Persian treasures by Alexander the Great and his Diadochs. Part of their analysis falls outside the scope of this research, but we can clearly observe three major peaks in the graph: around 280-271, c. 190-181, and 140-131. The first one might be related to the peak observed by the three authors for the early Diadochs, but most likely, it falls within the large issues of the new coinage of Antiochos I bearing Apollo seated on the omphalos on the reverse.[51] The second peak of 190-181 is also close to the one of 195 observed in the prices' analysis and may also be related to the war activity of Antiochos III in the area. The assumption that the clear drop after that period could be related to a possible drain of money to the west seems to be supported by our evidence as well.[52] The most significant peak is observed to 140-131 certainly to be related to the campaign of Demetrios II against the Parthians. This peak is also observed for the period 141-138 in van der Spek *at al*.[53]

This first analysis based on the extrapolation "SHD" method seems to support the evidence observed by van der Spek *et al*. It is necessary to keep in mind that the data used in our research are not as detailed (and sensitive) as those in van der Spek *et al.*'s analysis because of the different nature of data compared. Nevertheless, the general pattern points towards the same direction with significant peaks (and drops) in the quantity of silver observed around the same periods. The correlation observed between the two approaches validates the extrapolation method since most of the fluctuations of the data seem to match those by van der Spek *et al.* Furthermore, considering that the method was cross checked both against the die data (Ptolemies, section 4) and van der Spek *et al*., it is legitimate to extend our perspective. Given the

[51] Iossif 2011a arguing for the origin of this type and larger production at Seleucia on the Tigris.
[52] Van der Spek *et al.* 2014, 499.
[53] Van der Spek *et al.* 2014, 499.

fact that the image for the whole Empire is reliable and that of Mesopotamia proves to be reliable as well, it is only logical to assume that the "SHD" report also for coins in circulation in other regions. The following tables and figures offer an initial image for Asia Minor and the region of Levant and Syria:[54]

Decade	# Seleucid tetradrachms	# non-Seleucid tetradrachms	Total	% Seleucid tetradrachms
300-291	42	496	538	8,5
290-281	217	1960	2177	11,1
280-271	27	995	1022	2,7
270-261	2	35	37	5,7
250-241	256	3955	4211	6,5
240-231	35	155	190	22,6
230-221	34	282	316	12,1
220-211	38	390	428	9,7
210-201	192	523	715	36,7
200-191	160	1218	1378	13,1
190-181	269	1605	1874	16,8
180-171	1	162	163	0,6
160-151	46	313	359	14,7
150-141	469	6916	7385	6,8
130-121	29	139	168	20,9
120-111	138	138	276	100,0
110-101	1	34	35	2,9
100-91	16	105	121	15,2
80-71	7	165	172	4,2
Total	**1979**	**19586**	**21565**	**10,1**

Table 20: Hoards found in Asia Minor analyzed by decade. *Source*: Iossif forthcoming (a).

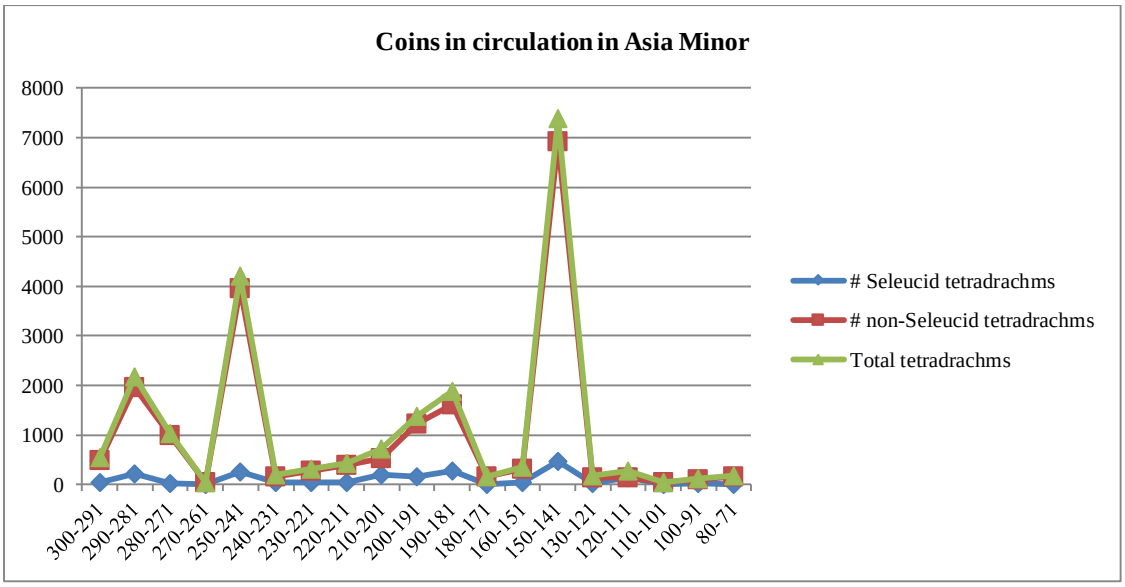

Figure 7: Fluctuation of tetradrachms in circulation in Asia Minor. *Source*: Iossif forthcoming (a).

[54] This is a conventional term coined for the purposes of this study comprising Coele-Syria, Syria *Seleukis*, and Phoenicia.

Decade	# Seleucid tetradrachms	# non-Seleucid tetradrachms	Total tetradrachms	% of Seleucid tetradrachms
300-291	24	227	251	10,6
290-281	27	901	928	3,0
280-271	2	8	10	25,0
260-251	0	0	0	0,0
250-241	13	13	26	100,0
240-231	2	10	12	20,0
230-221	9	50	59	18,0
220-211	14	30	44	46,7
210-201	70	387	457	18,1
200-191	7	34	41	20,6
190-181	25	213	238	11,7
180-171	94	114	208	82,5
170-161	212	632	844	33,5
160-151	49	65	114	75,4
150-141	1515	1753	3268	86,4
140-131	241	349	590	69,1
130-121	622	624	1246	99,7
120-111	306	501	807	61,1
110-101	449	580	1029	77,4
100-91	51	51	102	100,0
90-81	1	34	35	2,9
80-71	68	69	137	98,6
70-61	2	24	26	8,3
Total	**3803**	**6669**	**10472**	**57,0**

Table 21: Hoards found in Levant & Syria analyzed by decade. *Source*: Iossif forthcoming (a).

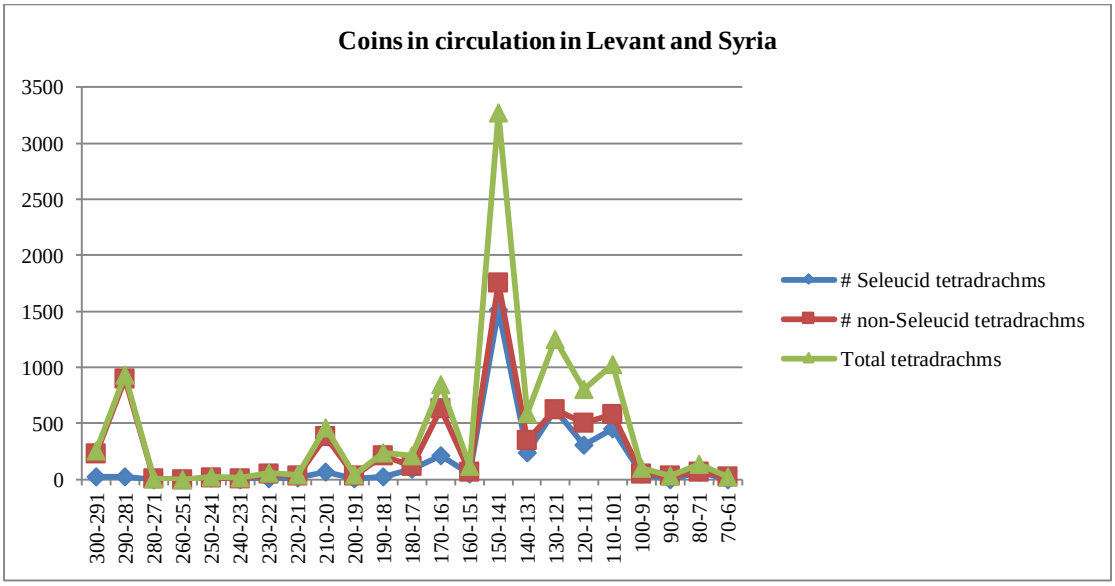

Figure 8: Fluctuation of tetradrachms in circulation in Levant & Syria. *Source*: Iossif forthcoming (a).

Different patterns are to be observed for these regions. Since their analysis goes beyond the scope of this article, I will limit myself to some preliminary conclusions. In Asia Minor, the quantity of Seleucid silver is a small fraction in the pool of circulation and the small peaks observed in 240-231 and 210-201 can be explained with the military activities in the area during the Third Syrian War and the ensuing War of Brothers opposing Seleucos II to Antiochos Hierax, and with the presence of Antiochos III in Asia Minor following the eastern Anabasis.[55]

The pattern is different in Levant and Syria where the Seleucid material becomes the principal component of numismatic circulation only after 180-171, a phenomenon to

[55] For an extended analysis of the data, cf. Iossif forthcoming (a).

be related to the loss of Asia Minor and the importance of Antioch as the most prolific mint of the Empire (see above the discussion following table 10 for the importance of this decade in the balance of numismatic production).

6. *En guise de conclusion*

Extrapolation methods like the one used extensively in this article cannot replace die studies. Nevertheless, when used with caution, they can offer interesting and reliable results. Since the "SHD" proves to be reliable, some important questions can be answered or, at least, begin to be answered. Aperghis claimed that a great quantity of silver left Babylonia following the armies toward the west.[56] This statement can now be quantitatively supported: coins produced in Mesopotamia travel to the west in significant percentages until 181 as can be seen in **table 11**; the same is also true for the major mint in the area, since Seleucian coins are primarily found in Asia Minor.

Decade	Asia Minor	Levant & Syria	Armenia	Mesopotamia	Greece	Without Provenance	Baktria	Upper Satrapies	Total
300-291	23,8%	30,0%	0,0%	17,5%	0,0%	0,0%	0,0%	0,0%	**71,3%**
290-281	53,8%	3,8%	1,2%	3,8%	1,2%	0,0%	0,0%	0,0%	**63,8%**
280-271	18,7%	1,9%	0,0%	69,2%	1,9%	0,0%	0,0%	0,0%	**91,6%**
270-261	28,6%	0,0%	0,0%	0,0%	14,3%	0,0%	0,0%	0,0%	**42,9%**
260-251	0,0%	0,0%	0,0%	0,0%	50,0%	0,0%	0,0%	0,0%	**50,0%**
250-241	46,0%	4,7%	0,0%	0,0%	2,2%	0,0%	0,0%	0,0%	**52,9%**
240-231	28,6%	1,3%	0,0%	32,5%	0,0%	0,0%	0,0%	0,0%	**62,3%**
230-221	1,0%	0,5%	0,0%	2,1%	0,6%	57,7%	0,0%	0,0%	**61,8%**
220-211	34,4%	8,2%	0,0%	0,0%	9,8%	0,0%	0,0%	0,0%	**52,5%**
210-201	17,3%	7,5%	3,0%	10,3%	0,0%	0,0%	0,0%	8,5%	**46,6%**
200-191	13,3%	2,0%	0,0%	9,3%	0,0%	9,7%	0,0%	0,0%	**34,3%**
190-181	28,6%	1,5%	0,0%	9,2%	0,0%	2,7%	0,0%	0,0%	**42,0%**
180-171	0,0%	7,1%	0,0%	14,7%	0,0%	0,0%	0,5%	0,0%	**22,3%**
170-161	0,0%	6,1%	0,0%	0,0%	0,4%	0,0%	0,0%	0,0%	**6,5%**
160-151	0,0%	1,7%	0,0%	0,0%	0,0%	0,0%	1,7%	0,0%	**3,4%**
150-141	0,0%	0,1%	0,0%	0,2%	0,0%	0,0%	0,4%	0,0%	**0,8%**
140-131	0,0%	0,6%	0,0%	23,4%	0,0%	0,0%	0,1%	0,0%	**24,1%**
130-121	0,0%	0,0%	0,2%	0,0%	0,0%	0,1%	0,0%	0,0%	**0,2%**
120-111	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	**0,0%**
110-101	0,0%	0,4%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	**0,4%**
100-91	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	**0,0%**
90-81	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	**0,0%**
80-71	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	**0,0%**
70-61	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	**0,0%**
60-51	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	**0,0%**
Total	**5,8%**	**1,4%**	**0,2%**	**5,0%**	**0,3%**	**6,6%**	**0,2%**	**0,3%**	**19,9%**

Table 22: Coins produced in Mesopotamian mints classified by burial data and region. *Source*: Iossif forthcoming (a).

This method offers unlimited options, even though de Callataÿ would criticize my "lyrisme poètique" when presenting the "possibilités infinies d'une telle méthode". It can show, for example, that the relative sizes of the economies of two most important Hellenistic dynasties were more or less the same size and the level of monetization of both economies was also extremely low when considering the wealth of these kings. Relating the observed number of coins in "SHD" with the original "estimated" number of dies issued by a mint is also a way to estimate the original volume of coins produced by the Seleucids. This allows us to corroborate historical hypotheses as to the sizes of armies or the payment of the troops not only in silver but also in bronze

[56] Aperghis 2004, 29-30.

coins and in kind.[57] Interesting possibilities, impossible to perform a generation ago, are also possible thanks to "SHD" (and the "Seleucid Excavation Database-SED"); a comparison of the speed of coin diffusion between the Seleucid empire and the Eurozone, as can be demonstrated by the study from Iossif, van Leeuwen, and Foldvari in the present volume. More data are needed and the numismatic evidence should be corroborated by other types of data, which could then provide a more general image of the quantitative aspect of Hellenistic economies.[58]

[57] de Callataÿ 2000; Psoma 2009.
[58] Cf. Iossif 2014 for a quantitative analysis combining coins and seals from Seleucia on the Tigris.

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Appendix: Hoards mentioned in this study[59]

Hoard	SHD ID number	Reference	Burial date
Aksaray, anc. Gaziura, Cappadocia	1	*IGCH* 1400	c. 300
Asia Minor, 1970	2	*CH* 1.55	293/2
Ancara, c. 1913 ("Angora Hoard")	3	*IGCH* 1399	294/90
"Seleucus I Hoard"	4	*CH* 10.288	281
Mersin, Cilicia, c. 1963	5	*IGCH* 1424	280
Gordion, 1959 ("Gordion Hoard III")	6	*IGCH* 1403	280
Manisa, Lydia, 1971	7	*IGCH* 1293	280
Turkey 1973/4	8	*CH* 1.56	280
Armenak, near Adana, Cilicia, 1927	9	*IGCH* 1423	275-270
North Aia Minor, 1970	10	*IGCH* 1368	265
Asia Minor, before 1983	11	*CH* 9.494	250/240
Sardis, Lydia, 1911 ("Sardis Basis Hoard")	12	*IGCH* 1299=*CH* 9.499	240
Meydancikkale, Cilicia Trachea, 1989	13	*CH* 8.308=*CH* 10.269	246-235
Asia Minor, 1972	14	*CH* 1.73	235-230
Beirut, 1964	55	*IGCH* 1519	300
Antakya area, 1994	56	*CH* 8.250	295
Aleppo, anc. Beroea, 1933	57	*IGCH* 1524	290-280
Phoenicia, 1997	58	*CH* 9.483	285-280
Lattakia, 1940	59	*IGCH* 1523	284
Syria?, 1966	60	*IGCH* 1525	280
Near East, 1981	61	*CH* 7.66	280
Bab, environs, 1944	62	*IGCH* 1534	250-200
Hüseyinli, near Antakya, 1986	63	*CH* 9.489	259/8
Syria?, before 1917	64	*IGCH* 1527	245
Tell Sukhas, near anc. Gabala, 1958	65	*IGCH* 1527	240
Diyarbekir, anc. Amida, Armenia, before 1938	154	*IGCH* 1734	290-280
Diyarbekir, anc. Amida, Armenia, 1972/1973	155	*CH* 1.59	235?
Failaka, anc. Icaros, Kuweit, 1984	163	*CH* 8.256	295-293
Hillah, environs, Babylonia, before 1945	164	*IGCH* 1759	290-285
Babylonia, c. 1900? ("Haynes' Babylonian Hoard")	165	*IGCH* 1761	280 or 260
Tell Halaf, Oshroene, 1913	166	*IGCH* 1763=*CH* 8.302	240 or 235
Mesopotamia, before 1920 ("Gejou's Mesopotamian Hoard")	167	*IGCH* 1720	230
Nimrud on the Tigris, Adibene, 1957	168	*IGCH* 1766	End 3rd c.
Failaka, anc. Icaros, Kuweit, 1960	169	*IGCH* 1767	210-200
Unknown findspot (Mesopotamia?), 2003	170	*CH* 10.274	210
Failaka, anc. Icaros, Kuweit, 1961	171	*CH* 8.342	200
Mesopotamia, 1914-1918 ("Dunne's Hoard)	172	*IGCH* 1769	195-190
Dura-Europos,	173	*IGCH* 1770	187

[59] The succession of hoards in the "SHD" follows a geographical classification. Within each region, the hoard are classified chronologically.

Mesopotamia, 1933-1934			
Urfa, anc. Edessa, Mesopotamia, 1924	174	*IGCH* 1772	185-160
Zivnik, anc. district of Gordyene, Mesopotamia, 1962	175	*IGCH* 1771	175
Unknown findspot, c. 1965	176	*CH* 10.281	(200-)175
Near East, 1977	177	*CH* 4.55	160
Babylon, Babylonia, 1900	178	*IGCH* 1774	155-150
Midyat environs, Mesopotamia, before 1950	179	*IGCH* 1775	150
Dura, c. 7 km SW of Hebron, spring 1975	180	*CH* 9.529	146/5 or 143/2
Mesopotamia, 1953	181	*IGCH* 1776	145
Mesopotamia, 1925	182	*IGCH* 1777	140
Bagdad environs, Mesopotamia, 1954	183	*IGCH* 1778=*Trésors* 26	136
Tell Ahmar, Mesopotamia, 1929	184	*IGCH* 1780	110-105
Warka, anc. Orchoi/Uruk, Babylonia, 1912	185	*IGCH* 1783	100-75
Midyat environs, before 1950	186	*IGCH* 1782	80
Mardin environs, 1952 (?)	187	*IGCH* 1784=*Trésors* 34	60-55
Basra environs, 1955	188	*IGCH* 1786	45
Nisibis, Mesopotamia, 1955	189	*IGCH* 1788	31 (after)
Pasargadae, Persis, 1962 (“Pasargadae Hoard I”)	190	*IGCH* 1795	299
Pasargadae, Persis, 1963 (“Pasargadae Hoard III”)	191	*IGCH* 1793	298/7
Persepolis, Persis, 1934-1935	192	*IGCH* 1797	300 (after)
Qazvin, Media, 1964	193	*IGCH* 1796=*CH* 1.58	275
“Frataraka”, probably from Persis, 1986	194	*CH* 9.481	275-250
Atrek Valley, anc. district of Hyrcania, 1965	195	*IGCH* 1798	209
Susa excavations, 1934-1939	196	*IGCH* 1808=*Suse* hoard no. 4	175
Persia, 1932-1933	197	*IGCH* 1801	160
Iran, c. 1970	198	*IGCH* 1802=*CH* 1.81	150?
Hamadan, 1977	199	*CH* 10.306	148/7
Unknown findspot (commerce), 2001	200	*CH* 10.307	148/7
Huh-i-Tuftan, anc. district of Drangiana, 1902	201	*IGCH* 1803	140
Susa excavations, 1933-1934	202	*IGCH* 1804=*Suse* hoard no. 5	140 (after)
Susiana, 1958-1959	203	*IGCH* 1805	138
Susiana, 1965?	204	*IGCH* 1806	138
Susa excavations, 1951-1952	205	*IGCH* 1809=*Suse* hoard no. 3	145-100
Susa excavations, 1934-1939	206	*IGCH* 1807=*Suse* hoard no. 7	125
Susa, Susiana, 1947-1948	207	*IGCH* 1812=*Suse* hoard no. 6	90 (after)
Afghanistan, 1973	208	*CH* 7.72	246
“Early Bronze Hoard”	249	*INJ* 17, 2010, 15-33	261-241