Sense and nonsense in the statistical approach of Babylonian prices[1]

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Introduction

Economic history of the ancient world is usually impaired by the lack of numerical data which allow statistical approach. It is therefore a great excitement for the historian of the Hellenistic period to find a fairly detailed recording of prices of food and wool over a period of more than four centuries in the so-called astronomical diaries from Babylon.

The astronomical diaries give us a unique view of the development of prices over a very long period of ca. 464 - 61 B.C. in a degree of detail which is exceptional for ancient history. The diaries are monthly reports, copied on clay tablets in the Babylonian cuneiform script, of the movement of the planets in the starry sky. For historical research it is of the utmost importance that the astronomers to an increasing extent noted down observations of other kinds at the end of the monthly reports. They registered the purchasing power of the shekel (ca. 8.33 grammes of silver, roughly two drachms) in relation to five basic foodstuffs: barley, dates, mustard (cascuta?), cress (cardamom?) and sesame (all in litres[2]), and wool (in

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[1]   Review of: Alice Louise SLOTSKY, *The bourse of Babylon. Market quotations in the Astronomical Diaries of Babylonia.* Bethesda, Maryland, CDL Press, 1997 (24 cm., xiv + 192 pp.). ISBN 1-883053-42-0 and Jean ANDREAU, Pierre BRIANT, Raymond DESCAT, eds., *Économie antique. Prix et formations des prix dans les économies antiques.* Entretiens d'Archéologie et d'histoire Saint-Bertrand-de-Comminges 3. Saint-Bertrand-de-Comminges, Musée archéologique départemental, 1997 (25 cm., 415 pp.). ISBN 2-9502446-9-6.

[2]   The capacity of the Babylonian litre (SÌLA/*qû* or *qa* (a fossilized accusative)) is subject to debate. In modern literature the capacity is cumputed as being 0.946 and 0.842 litres. Slotsky uses both measures on one page (p. 46, one in the text, one in table 1). For the *mina* Slotsky also uses a double standard: 453.60 grams in the text, c. 505 grams in table 1. Fortunately, Marvin Powell, an expert in ancient metrology, has suggested in view of the uncertainties to stick to one litre for a *qa*, 500 grammes for a mina (thus 1/60th = 8.333 grammes for a shekel) and 50 cm. for a cubit, since these measures are related to each other, give a fair measure of accuracy and avoid errors: obviously a wise advise indeed (Powell 1984, 33, 41-42,

pounds). In addition they reported events of political and local (=Babylonian) importance: about campaigns of kings, about visits to the city of kings and high officials, about repairs of the temples, conflicts in the city, epidemic diseases, etc. The level of the Euphrates was also carefully registered. All this probably had an astrological purpose.

Recently these astronomical diaries have become accessible to a wider audience by the publication of the tablets in three volumes in transcription and translation by the late Abraham Sachs and by Hermann Hunger (1988, 1989 and 1996).

For the non-expert reader it will perhaps be useful to say something about the lay-out of this edition. The diaries are numbered according to the Babylonian year, which consisted of twelve lunar months of 29 or 30 days, with the occasional intercalation of an extra month after months VI or XII in order to keep up with the solar year: seven intercalations in a period of 19 years. The system worked very well, but it must be kept in mind that the Babylonian months moved backwards a whole month in the solar year within three years, before the situation was redressed by the insertion of an intercalated month. Consequently, the first month of the Babylonian year, Nisan, could start between March 24 and April 23; in one year April could roughly correspond with month XII, in another year with month I.

The editors have numbered the diaries corresponding to the Babylonian years before common era according to astronomical usage, which means that diary no. -330 corresponds to 331 BC, that is: the Babylonian year -330 runs from April 13, 331 to April 2, 330 BC. The Babylonian calendar is conveniently converted into the Julian calendar by Parker and Dubberstein (1956); minor corrections are given by Sachs and Hunger. In their edition different tablets concerning the same year are marked with A, B, C etc. In sum: when we speak about diary -330 I, we refer to the diary concerning the month Nisan of year 331 B.C.

The data concerning the commodity prices cry out for a statistical study and it is a good thing that Alice Slotsky took up the challenge and produced a book in which she has made these price notations accessible for a wider readership, especially in the table of all commodity quotations reported at the end of the month (Appendix B, p. 133-146), and presented a statistical analysis of this dataset.

In another volume, here also under review, containing the lectures and comments of a conference in St.-Bertrand-de-Comminges on price formations in the ancient world, the prices of the diaries are also discussed, among others by Slotsky herself, 'You can teach an old dog new tricks: computer age analysis of ancient data (prices in the astronomical diaries of -463 to

46). Consequently, her table 1 should be discarded. One *qa* is one litre, one *kur* is 180 litres.

-72),' p. 355-360, in response to the contribution of Peter Vargyas, 'Les prix des denrées alimentaires de première nécessité en Babylonie à l'époque achéménide et hellénistique,' p. 335-354. In the same volume Francis Joannès ('Prix et salaires en Babylonie du VIIe au IIIe siècle avant notre ère,' p. 313-334) et Carlo Zaccagnini ('Prices and price formation in the Ancient Near East. A methodological approach,' p. 361-384) discuss the material of the diaries.

The aim of this review article is to focus on the material of the Babylonian diaries and the methods by which this material can be interpreted, especially the statistical approach. This review is written by R.J. van der Spek, who is an ancient historian and half-baked assyriologist specializing in Hellenistic Babylonia with the assistance of C.A. Mandemakers who is an historian of modern history specializing in statistical approaches.

On method

All studies of the Babylonian prices in the diary are pointless, if it is assumed that the recordings are unreliable, by reasoning that the astronomers could hardly have had the means to establish an overall price for the city of Babylon concerning the prices of so many commodities, or that the recorded prices are computed according to certain preconceived astrological premises. The huge oscillations of the prices would point to that. This stance was indeed upheld by Joannès and Zaccagnini in the volume under review. Dr. Slotsky, on the other hand, maintains that the prices are reliable, and I think correctly so. As I have argued elswhere (2000: 295-7) in support of Slotsky's reasoning, the prices are as trustworthy as the other reports of the diaries, for which evidence exists outside the diaries. Consequently, a serious (statistical) study of the diary prices is worthwhile indeed and Slotsky's study is thus a desideratum.

However, although Slotsky's book has its merits, we have some reservations regarding her historical-statistical approach. Slotsky's method is purely mathematical with a complete disregard of the historical reality behind the data, which make her calculations and tables too academic. A more general criticism we have is that Slotsky has used the price tables to reproduce them in more descriptive and sophisticated forms, but no more than that. Appendix D, 'Method of Analysis,' is a good example. Principal component analysis to create a kind of index for the five foodstuffs is a good approach, but is of little value if there is no consequence by using these figures in any kind of follow-up analysis. Recently this lack of analysis has been overcome by Peter Temin in his renewed analysis of the price lists of

Slotsky (Temin 2002). Let us illustrate our criticism of Slotsky's approach with a few points.

It is of course interesting to study trends in prices, which she does in chapter IV ('Analysis of commodity prices'). However, her learned calculations and graphs may respond to modern statistical methods, but these are of little value if the historical questions have not been correctly defined beforehand. The definition of an *historical* problem asks for a corresponding *statistical* model. Let us be more precise. Slotsky opts for a model with two points of inflection, which produces a cubic equation. Why she does so is not argued. Ideally one departs from a theory which predicts the points of inflection, which produces a certain curve, which has to be tested as fitting as much as possible historical reality. In our view it is better not to make one model for the whole period of 400 years, but to consider certain segments taking into account important historical events. We suggest: 1. The (later) Achaemenid period (463-331 BC); 2. The period of Alexander the Great and the Wars of the Successors (330-301 BC); 3. The Seleucid period (300-141); 4. the Arsacid period (141-61 BC). Despite the obvious price oscillations within these periods the following trends are detectable: Fairly high prices in the Achaemenid period, but falling prices at the end of it; extremely high prices during the wars of the Successors; apart from exceptions, fairly low prices in the Seleucid period; high prices in the Arsacid period. A model with more points of inflection would elucidate this. Slotsky's model with two inflection points does not reveal this. Slotsky uses her model only for describing the data, not for explaining them. In any case the choice of the type of equation should have been thoroughly argued.[3]

There is another point which proves that one should be very careful in handling statistical material. Table 3 (p. 52) gives the minimum, maximum, mean and median prices in *girû* (i.e. 1/24th of a shekel). Mean prices are average prices, the median price is the price above which half the quotations fall. This table shows that in all cases, i.e. for barley, dates, mustard, cress, sesame and wool, the median price is higher than the mean price. Now this seems puzzling, because it is to be expected that in food prices the median is lower than the average price. This is explained by the very inelastic nature of the demand for basic foodstuffs: people do not eat much more when the supply of grain is vast, but they pay a lot more, when supply is scarce.

Slotsky does not give an explanation for this phenomenon. After some puzzling we have found the answer. In table 2 (p. 50) she calculates the commodity statistics (minimum,

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[3] Cf. Temin 2002: 51, also uses a third-order polynomial without considering alternatives.

maximum, mean and median *quantities* bought for one shekel for each good) on the basis of the data of Appendix B (table of the end of month quotations of the number of litres of foodstuffs to be bought for one shekel). The *price* statistics (in *girû*) for these goods she calculates in table 3. However, these statistics are not directly based on the dataset in Appendix B, but the result of a reconstruction of table 2. By calculating in this way she falls into the trap of recalculating the mean of the *prices* on the basis of the mean of the *quantities*, instead of first converting the quantities per shekel into prices per litre for *each* item and then calculating the mean price.[4]

When one works in the correct order, i.e. first converting the litres for a shekel into shekels per litre, the statistical results are completely different: the median price indeed appears to be lower than the mean price.

Slotsky's statistical knowledge may be sometimes outof order, her historical knowledge of the period is very disappointing indeed. One of the major events of the history of later Babylonia was the conquest by the Parthians in 141 BC, but Slotsky seems not to know when that event took place. On the one hand she seems to think that the (backdated) beginning of the Arsacid Era (Year 1 = year 65 Seleucid Era = 247/6 BC) was the beginning of the Parthian occupation. This is apparent from Appendix B: 'the End-of-month database', and even more from Appendix C: 'Diaries of Database by reign.' In this list of kings she starts mentioning the Arsacid kings from -246 (= 247/6 BC), though in square brackets alongside the Seleucid kings, as if she knew that they had not yet power in Babylonia. However, she continues dating by the Seleucid kings after 141 BC until 94/3 BC, where she miraculously puts the "end of Seleucid dynasty", followed by Gotarzes, who nevertheless retains his square brackets.

Not only the tables, but also the running text shows her garbled knowledge of the political history. On p. 41 she is surprised to see king Arsaces and king Demetrius II in the historical section of one tablet (-137 A), not realizing that Demetrius was at that moment not ruling Babylonia, but trying to reconquer it from the Parthians, without success however, since he was taken prisoner. It is precisely this event that was described on this tablet (cf. now Van der Spek 1997/8: 172-3). On pp. 21 and 45 she assumes that Seleucid kings were still ruling Babylonia in 138/7 BC (Antiochus VII) and in 126/5 BC (Demetrius II/Cleopatra Thea/Alexander II Zabinas). On p. 47-8 and 59 she really thinks that the beginning of the

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[4] Temin 2002 and Müller 1999/2000 did not fall into this trap, but used real prices. However, they did not treat the problems concerning the mean and average prices.

(backdated) Arsacid dating system in 247/6 (which was actually introduced in 141 BC) influenced prices. Slotsky seems also not to know that the kings Philip III and Alexander IV, though featuring in the dating system of the diaries, exercised no real power. All this embarrassing lack of elementary historical knowledge is exhibited in tables 10 and 11 (p. 84-87).

Seasonal price fluctuations

One of the main conclusions of Slotsky's study is the observation that "seasonal effects were not significant in the diaries' data for barley, dates, cress/cardamom, and wool" (p. 69). As Slotsky admits, this is a surprising conclusion "in the light of the extant documents which show that debt for land rentals or seed were due at the time of the harvest and payable in produce at the rate of the harvest month." Thus there is good reason to call in question the result of Slotsky's calculations.

We very much doubt whether the procedure is statistically adequate in view of the following considerations.

1. The months which produce data are unevenly distributed, as is shown by table 1.

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Table 1: number of barley quotations per month in Appendix B

I	19
II	24
III	18
IV	14
V	12
VI	22
VI^2	2
VII	18
VIII	12
IX	14
X	17

XI	22
XII	13
XII^2	4
Total:	211

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The pre-eminent harvest-month (II) is represented by 24 entries, while months VIII and IX have only (approximately) half of it. No month has more entries which is not very much over a period of nearly 400 years.

2. Though month II is the pre-eminent harvest month, it is not the only harvest month. Due to weather and water supply conditions, harvest may occur earlier and later. Furthermore, the Babylonian calendar is a lunar calendar. As explained above month II moves backward in the solar year ca. one month in three years and then returns to its former position after in-tercalation of a month following month VI or XII. So it is possible that the harvest started already in month XII or XII^2 (as was probably the case in -247) and continued into month III or even IV. In addition threshing and winnowing took time and could retard the appearance of the barley on the market.

3. The reliability of the statistics is diminished by the enormous price fluctuations in the different years and by the fact that in no year months are all represented; as a matter of fact most of the years are represented by 0-3 entries only. Year -187 is only represented by one month, month VII, with the extreme low barley equivalent of 390 litres for a shekel (the all times record), which is not a harvest month. The harvest month II might have given an even lower price, but we simply do not know. The same phenomenon is at hand in -164, where month VII gives 378.5 litres as the sole record of that year. Meanwhile these exceptional figures contaminate the file, which contains only 18 months VII.[5]

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[5] Gerfrid Müller (1999/2000) also doubts the conclusion of Slotsky that there were no seasonal fluctuations in price levels, especially because the regression method used by Slotsky tends to middle away that kind of variation.

Temin concluded that barley and dates were more expensive prior to harvest time, but mustard was more expensive, while "the other three prices did not have seasonal patterns that can be recovered from the data with confidence" (p. 57). He also could not find any influence of the level of the Euphrates on prices. "The season evidence, therefore, is ambiguous" (p.

4. It is possible to check Slotsky's assertion that seasonal price fluctuations are not the rule by looking at the years in which more than one or two months are mentioned. As a matter of fact only very few years give the required information. Then we see that only in eleven years of the entire period of about 400 years a price trend is visible that, at first sight, is contrary to seasonal factors: -308, -277, -247, -207, -197, -182, -163, -107, -105, -90 and -85. And this number may be reduced when we take a closer look at the data, and take a look at all data, not only the end of month quotations.

-308: month V has the one of the lowest recorded equivalent in the diaries (9 litres for a shekel), in month VI it is already a little better: 14 litres. It is clear that the situation is exceptional: month V is the very month in which in or near the city a severe battle took place between troops of Antigonus and of Seleucus (Van der Spek 2000: 437). So there is nothing strange here.

-277: months I and II record 180 l., IV - VI are missing, VII and IX mention 270 l. The year started early: 1 Nisan = 29 March 278 BC; end of month II = 26 may. If the harvest was late in this year, it could have continued in month III, so that the lower prices occurred only then. The prices in this period are very low indeed, and price development may have been affected by the donation of land to the city of Babylon by Antiochus I two years before (Van der Spek 1993:67f). Prices in -273 are again much higher (36 litres in month VII and XII), which may be attributed to the reverse policy of this year: the expropriation of this land and the war effort of this year (Van der Spek 1993: 67ff and 2000: 305ff).

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57). It should be noted that the other crops could more easily be sown and harvested in different seasons, than barley and dates; cf. Slotsky p. 33, 35-6, 38.

Müller (1999/2000) made an analysis of the relationship between the level of the Euphrates and the barley prices. He concluded that there was no demonstrable dip in the water level during 130-110 B.C. despite Slotsky's analysis, presented in figure 32 (p. 97). Müller showed that the price of barley and the water level rose after 170 B.C. He looks for an explanation of this phenomenon in the climatic change which has been found for the period after 150 B.C. with higher temperatures and more rainfall. This is supposed to have changed the time of the yearly flood and have caused a higher air humidity near the ground, which could have stimulated fungal infections of the barley and in both ways could have lowered yields. This explanation seems to be a little sophisticated. Good water supply is hardly a good explanation of bad harvests. The political instability of the period is a more acceptable and clearly demonstrable cause of the high price levels.

-247: It is indeed remarkable that prices are three times lower in month X than in month VII, but the even lower prices in month XII^2 (starting 17 March) may be caused by early harvesting. Month I of the next year has, as is to be expected, a slightly lower price, caused by the continuation of the harvest. A royal land grant made by Antiochus II may have played a role (Van der Spek 1993: 72)

-207 This year does not completely contradict seasonal expectations, if we consider all quotations. Prices are gradually falling from the beginning of month I: 48 litres in I, 90 l. in beginning, 168 in the middle and 144 at the end of month II. We do not know III-V, but in month VI or VII the equivalent is 174 litres. This favourable figure is remarkable, but month III (1 June) may have brought more barley to the market.

-197 Indeed remarkable falling prices between month VII and XI, but only slightly (144 - 150 - 174 litres for a shekel); however, we do not know the prices of month I - III.

-182 follows more or less the expected pattern: Month II 216 litres in the middle of the month, 168 at the end, and again 216 in month VI (which is indeed surprising), but falling again in VIII to 180. The recorded equivalent of month XI, 204 litres, is suspect: the tablet is broken and it is actually preferable to read '132' litres (+3 PI+ 4 BÁN instead of [1 GU]R 4 BÁN).

-163 seems to contradict the expected pattern, but in fact it does not. Month VIII records 72 litres for a shekel, month XII 93. Here Slotsky's usage only to give end of month quotations shows its draw-backs: the complete list is: 96 litres for a shekel at the beginning of month I, falling to 63 litres at the middle of month VIII, surprisingly but not spectacularly rising slightly to 72 at the end of the same month, rising to 78 litres at the middle of month XII and to 93 litres at the end of month XII, which is more or less at the same level as it was at the beginning of that year. The earliest harvesting seems to have begun in month XII, which ended March 16.

-107 The rise from 27 to 40 (months IX and XI) is a little irregular, but month VII conforms the pattern: 54 and 51 at the beginning and the middle of the month (not recorded by Slotsky). Furthermore: year -107 was a turbulent year: it was a year when a certain general Mithradates

marched around in the regions of Babylon and Seleucia. This Mithradates caused a lot of trouble in Babylonia during these years. In month IX there was "wailing and anxiety in the city" and "until the 22nd, selling was interrupted in the streets of Babylon", to be resumed later, when the prices were high: only 27 litres for a shekel. New supplies apparently lowered the prices somewhat (see also below).

-105 seems to be contradictory, but the full list is much more normal. The full documentation is: month I: 48-52-54-60; II 60-72-75 (72 new barley); III, day 1-10: 77. So far completely conform expectation: falling prices in the harvest months. The only strange thing is that prices slightly fall to 81 litres for a shekel in month VI. The diary itself may have given the explanation: in month III diseases inflicted the land, so that many people may have died, which - cynical though it may be- must have decreased demand.

-90 is puzzling: in the months VIII - XI equivalents rise from 40 to 65 litres. The harvest months are not recorded and we have not a complete picture.

So one must conclude that only in a few years (-277, -247, -182 and -90) prices follow a really exceptional course and in some others minor irregularities may be discerned.

On the other hand twice as many years present the expected downward trend of the prices: -418 (lowest price in month III, starting 25 May), -381, -372, -345, -324, -322, -289, -253, -191 (months I-IV missing), -186, -183, -179, -158, -156, -140, -137, -136, -124, -122 (harvest in month III starting 24 May), -95, -93 (to be completed by texts 13 and 18 of the Rahimesu-archive: 90 litres in months XI-XII[2]; cf. Van der Spek 1998), -77.

So we think that the only conclusion can be that Slotsky's deductions concerning barley are wrong. The data set is obviously too small and so much contaminated by exceptional data, that the statistic method fails here. We must conclude by looking at the more or less well preserved years, that normally prices conform to seasonal influence, but not always and these exceptions demand an explanation, and in most cases an explanation can be given.[6]

Price control measures by the authorities as an explanation for unexpected price trends

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[6]   Note the same problem in Roman Egypt (Rathbone 1997: 195).

The economic "law" of seasonal price fluctuations is evidently only valid *ceteris paribus.* As Slotsky admits, various factors may influence the prices, such as destructive weather, locusts, diseases, changes in agricultural practices and market control by the authorities (p. 105).

From these factors destructive weather and locusts may be ruled out: they may raise prices even more after the harvest. Changes in agricultural practices cannot influence prices within one year either. Price control by the authorities is a possibility, but it is unlikely and there is no evidence for it despite Slotsky's arguing in favour of it (p. 22, 28, 31 and 105).

Price control measures are unlikely in view of the enormous price oscillations. If there was market control, it must have been very unsuccessful. Slotsky finds the evidence for state intervention in expressions like: "The sale of barley and everything else was cut off in the streets of Babylon until the fifth" (diary of –324; month II, 1-5 = 6-10 May 325 BC) and "selling was interrupted in the streets of Babylon" (diary -107 D 'Obv.' 31'-32'). This expression, always with the passive tense of the verb *parāsu*, is found five times in the diaries. Apart from the quotations above, it is found in -164 XII, -62 I. In -82A I, the verb *parāsu* is not used, but [...*im*[?]]-*meš-ku-ú*, "stopped". On the basis of these texts Slotsky concludes: "These market shutdowns to combat shortages and the subsequent delivery of supplies brought from supplementary sources indicate that the commodity market was closely watched and subjected to correction when necessary." (p. 28)

This conclusion, based on very few data, misses the mark completely and is arrived at without regard for the historical circumstances. The only thing these texts want to say is that in the months or days in question, the supply of grain was so limited, that nothing could be bought in the streets of Babylon. This is no market shut-down to combat shortages (it is a silly policy to stimulate supply of grain by closing the market). Mrs. Slotsky must have been misled by Hunger's translation of *parāsu*, 'to cut off.' In the passive tense, however, it simply means 'to fail to occur' (AHw II, 832a: 'ausbleiben'; cf. Van der Spek 2000a: 300). This interpretation of *parāsu* is certainly also required in -107 C XII; -85 C X, - 77 XI, where this word is used to indicate that in these winter months rains and floods kept off. That this state of affairs is the result of divine, not of human intervention, is indicated in a letter by the agent and astrological advisor of Esarhaddon: "If Neberu (=Jupiter) drags: (...) the gods will be angry, rains and floods will cease (A.AN.MEŠ *u* A.KAL.MEŠ *ip-par-ra-su*)" (Parpola 1993, no. 362: 3-6). What is recorded here is the opposite of what is given in Akkadian prophecy A II:7 ŠÈG.MEŠ *u* A.KAL.MEŠ GÁL.MEŠ, "there will be rain and floods" as a mark of a

prosperous reign.[7] But Slotsky (p. 98) thinks that the government was responsible for this. According to Mesopotamian thinking she is right: the king is responsible for rains and floods because of his mediating rôle between gods and mankind, but a modern scholar ought to be sceptical about his capabilities in this.

It is no coincidence that all quotations concerning the supposed "market shut-downs" refer to months in which prices are extremely high. These extreme high prices have indeed in all(?) cases to do with actions of the authorities. These actions, however, are not price regulations, but food requisitions; they concern warfare and movements of armies, which entailed the removal of a lot of grain from the market for the provisioning of the army.

In -324 II (May-June 325 BC) the shortage may have been caused by governor Harpalus, who was a spendthrift (Van der Spek 2000a: 301 (suggestion G.G. Aperghis)). However, what happened exactly on May 6-10, 325 BC we simply do not know.

The report of diary -164 XII, "25th and 26th, the sale of barley was cut off," seems to contradict the rule that the expression occurred in times of high prices since five months before a shekel of barley could buy 378.5 litres of barley. But the diaries teach us that it was the year when Antiochus IV conquered Armenia in month VII (or sometime before), and then marched southward in the direction of the Persian Gulf.[8] It is to be expected that he passed Babylonia in month XII, the month usually just before harvest time, and he may well have taken the entire grain stock from the market. The consequences could be felt in the next year. At the beginning of month -163 II (harvest month!), the shekel only bought 96 litres of barley.

Diary -107 we discussed already above. Again, war is at stake. The prices were high and troops marched around.

Diary -62 I: We have no information on the situation in Babylon: the historical section (8 lines) of this diary is nearly completely destroyed.

Diary -82A I: (No. -82A Obv.' 15: [... *im*[?]]-+*meš*+-*ku-ú* ŠE.BAR *ina ma-lak* 3 1/2 *qa*.) This is a very difficult line and it is very hazardous to draw conclusions from it. It is translated by Hunger as "[....] stopped; barley on the way[?] 3 1/2 *qa*". Slotsky was apparently

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[7]   Grayson, Lambert 1964: 12 and 14. Cf. also CAD M II 71 s.v. *mīlu* 1 b): *zunnu u mi-*[*lu*] *ipparrasu*, "rain and flooding will come to an end" (KUB 4 63 iii 26) and ŠÈG.ME A.KAL.ME TAR.ME in Labat 1965: §104:6. It is again evidence for a close relationship between diaries and the science of divination.

[8]   Cf. Gera/Horowitz 1997: 243ff and Van der Spek 1997/8: 173. The low prices of month VII make the appearance of Antiochus IV in the Gulf region unlikely, *pace* Gera/Horowitz. I assume that the astronomer heard in month VII that Antiochus had conquered Armenia in that month, and made up for his campaign southwards.

misled by this translation. "... stopped" is not a transitive verb with the government as possible subject, but an intransitive verb, *namarkû*, meaning: 'to be in arrears,' 'to lag behind.' So again: barley was very expensive this month (see l. 14): only 6.5 litres for a shekel on the 7th, 6 litres on the 8th, 9th and 10th, information on the 11th, 12th and 13th is broken off, but probably the equivalents were even lower, after which it is said that the supply of barley was in arrears, but that there was barley on the way, which had the extreme high price of 3.5 litres for a shekel. The diaries show us that these years were very troublesome for Babylonia. Rebellious chieftains marched around; the diary of this particular month speaks about a revolt. Whatever the case, all this has nothing to do with a government policy of controlling the market.

Elsewhere I mentioned a few other factors: dumping at the market of grain surpluses by the "great organizations", temple and palace, later in the year. This too is not a deliberate policy of price setting, but an unintentional influencing of price levels (Van der Spek 2000a: 296 and 298).

Double harvests as an explanation for unexpected price trends

A further factor which might explain lower prices is the practice of a second harvest.

On p. 26 Slotsky mentions the following years in which a second barley harvest might have occurred in view of the lower prices later in the year: SE 34 (= -277), SE 3 (-308), SE 104 (-207), SE 129 (-182), SE 64 (-247) en SE 114 (= -197). We have discussed these texts above, and indeed, apart from SE 3 = -308, the development of the prices is in some respects contrary to expectation and may be explained by second harvests. It seems thus advisable to look for additional evidence for a second growing season. Our research, however, was not very comforting. We shall start with the positive evidence.

First, there is the explicit confirmation of Pliny the Elder, who says that in Babylonia grain was harvested twice, which enabled the Babylonian to produce seed:yield ratios of 1:50 up to 1:100 (*Naturalis Historia* 18.45.161-2).

Secondly, there are Babylonian lease contracts which mention excessive returns; actually the above mentioned BE 9, 30, which give a ratio 1:24[!], which more than doubles the average (Stolper 1985, 136, table 5).

Babylonian texts, however, which mention second harvests explicitly do not exist, and if it were common practice, it must have found its way into the texts. Texts, which are some-

times quoted as dealing with second harvests, are actually referring to other phenomena.

The occurrence of second harvests has been defended by F. Joannès in two instances (Joannès 1982, 74-79; 1995, 189). He sees the occurrence of second harvests in the occasional appearance of the expression *ebur kumat u kuṣi* ("winter and summer crops") in cuneiform texts. However, I do not believe that this has anything to do with with second harvests. The expression occurs in two lease contracts in the Murašû archive from Nippur, BE 9, 29 and 30, and is used there as a summary of rents to be paid of barley, wheat, emmer, chick peas, lentils, millet, sesame, mustard(?), garlic and shallot(?), which is subsumed as "summer and winter crops" (BE 9, 29: 10-15; 30: 12-16; 18-23. Thus by diversification farmers were able to produce crops the whole year around. The expression refers to different crops, of which some are harvested in summer, some in winter. The same is true for a lease contract (share cropping) in which the lessee is obliged to pay after a year (Joannès 1982, 74, no. 23). The contract is dated 7.III.7 Artaxerxes (II) and payment of the rent is due in month II of year 8, the normal month of the barley harvest and is defined as "1/3 of the winter and summer crop". This means that the lessee must pay one third of whatever he may grow; that the products are not specified is explained by the fact that a share cropping contract is concerned: it is not necessary to mention all the different crops, since the rent is one third in all cases. Yet one case is specifically mentioned, viz. a special regulation for the *kasû* ('mustard/cascuta'), which shows that in this text too a whole variety of crops is subsumed in the expression in question, as in the Murašû lease contracts.

Joannès (1982: 76) assumes a further reference to double harvests in the expression *iturrû* used in the context of harvest. However, this verb (from *tarû*, 'to return') does not say anything about a second harvest. It simply refers to the "return" of the seed corn, as the English equivalent does. The expression is not without parallel: Van der Spek 1995, 238, text 9: 11; CT 49, 136: 7-8 and 13-14 (= Van der Spek 1986, 232, text 9). Especially this text shows that *tarû* refers to the normal harvest in the spring: ŠE.BAR *u* ZÚ.LUM.MA MU-*a-tì šá ina* ŠE.NUMUN.MEŠ MU-*a-tì i-tur-ru-ma* /TA\ ITI BÁR MU 1 ME 18.KAM *ana* É *rama*^{ma}*-ni-iá al-te₉-qe,* "the barley and the dates in question which in the aforementioned field 'returned' from the month Nisan (I) of year 118 to month Siwan (III) of year 123 (SE), I have taken to my own house". Though second harvests are not excluded, the months referred to are the months of the normal barley harvest in spring time. Finally, I refer to OECT IX 62: 5-6 (= McEwan 1981, 68-71), i.e. a prebendary income comprising PAB *šá i-tur-ru i-na* 1 GUR 1 PI 4 BÁN, "the total of what is the return of 40 seah (surface measure of land)" cf. Van der Spek

1986, 207.

Slotsky also appeals to the authority of Van Driel (1987: 170) who indeed subscribes to Joannès' reasoning about the two Murašû contracts, but who is very cautious at the same time. Furthermore, Van Driel was a few years later even more sceptical (Van Driel 1990: 237f).

Finally, Slotsky (p. 69, n. 8) implies that the qualification "very good" barley in -203 VIII and -168 V must refer to second harvests, apparently supposing that very good barley must always be new barley. But this is not a compelling argument. The quality of barley depends very much on the way it is processed. Very good barley is pearled barley, from which husks and rachis fragments are removed. A litre of pearled barley contains more barleycorns than a litre of badly processed barley (Van der Spek 1998: 249f). So Slotsky's puzzle that the examples of good barley occur in four different months: I, V, VIII and IX (p. 26), is easily solved. There are references to "new barley" in the diaries, but they all belong to months I-III (refs. p. 25f), the normal harvest months.

Vargyas (p. 339f) suggests a more meaningful factor which may have had a favourable influence on barley prices in the autumn. In that period the harvest of the dates took place. This fruit, in quantity being the second foodstuff of the Babylonian diet, could alleviate the demand of barley and so have a favourable effect on barley prices. That people really switched over from grain to dates in times of scarcity is reported by Diodorus in describing Eumenes' march into Susiane in 317 BC: Eumenes "divided his army into three parts because of the dearth of food. Marching through the country in separate columns, he was completely without grain, but he distributed to his soldiers rice, sesame and dates, since the land produced such fruits as these in plenty" (Diodorus 19.13.6; cf. Van der Spek 2000a: 296). Eumenes arrived in October 317 BC in Babylonia (Chronicle 10, Obv. 14', Grayson 1975, 115f; Del Monte 1997: 183ff), and must have departed to Susiane at the time of the date harvest.

The volatility of the prices and the character of the Babylonian economy

Though over longer periods certain trends are apparent, the volatility of the prices remains remarkable and deserves special attention. The phenomenon gives invaluable information about the character of the economy in that it gives answers to the question of the

extent to which the Babylonian market was integrated in the world market. Karl Gunnar Persson has argued that "given the high costs of transport, the slow flow of information and the risky nature of local harvest carry-over, harvest fluctuations necessarily had a large impact on supply and prices. (...) The basic idea applied here is that market integration is related to the homogeneity of information in different markets and the opportunities for arbitrage and trade – that is, for exploiting the gains from moving goods from where prices were low to where prices were high" (Persson 1999: 91). Hence Persson expects "price volatility to *decline with the extent of market integration and over time"* (Persson 1999: 93; *italics* Persson).

If we take this into account, one must conclude that the integration of the market of Babylonia with the rest of the (Seleucid) world was poor. Price oscillations were caused by the alteration of good and bad harvests, but warfare at home also appeared to be an important factor. The arrival of a large army, even if it does not fight, can easily drive up prices, even in the case of a strong market integration. These facts may also occur in the event of a market integrated economy, but the effects will be blurred after some time. Thus, especially the extreme *low* prices in the diaries are telling. Apparently the Babylonians were not able to export grain in times of over-production. Thus it may not be a question of contingency of the survival of the written sources that we have no evidence for over-land grain trade from Babylonia.

The value of silver.

Just a few words about the value of silver. Silver is like grain a commodity, of which the price can rise and fall. The economic law of supply and demand is applicable to silver as on other products. Thus in the time after Alexander the Great, when a vast quantity of silver was put into circulation, the price of silver declined, which did cause inflation. In the time of Antiochus III and IV the reverse may have been at issue. Due to the defeat of Antiochus III in his war against the Romans in Greece and Western Asia Minor (190-189 BC), for which much silver must have been withdrawn from Asia, and the ensuing Peace of Apamea (188 BC) in which Antiochus had to pay 12,000 talents of silver in twelve annual instalments (= 36 million shekels) and 3000 talents at once (= 9 million shekels), silver became scarce in relation to other commodities, which made these relatively cheap. This means that the

extreme low prices of grain in Octover-November 188 BC may well have been effected by the scarcity of silver at that time. This means that study of the prices of grain is very complicated. They are determined by the supply and demand of grain as well as of silver. Thus factors like weather, warfare, political (in)stability, good and bad harvests and supply of silver all play their part in the setting of price levels.

Conclusion

The study of prices is an important tool for understanding the character of an economic system. It gives clues in the discussion about the measure in which the market was a basic feature of the ancient economy. The volumes under review present important material for this study. That market mechanisms played their part in the Babylonian economy seems now to be unquestionable, as was also the conclusion of Peter Temin (2002). This conclusion, however, does not entail that market had the same significance in ancient Babylon as in modern times. In ancient Babylonia great organizations like temple and palace with their ration systems determined the economic systems to a large extent and affected prices in a way which is not always clear to us. Exceptional circumstances like wars, political (in)stabilities, plagues and droughts were other factors. Price regulation by the authorities, at least in the Hellenistic period, could not be found, despite Slotsky's assertions to the contrary.

The Hellenistic period in Babylonia is a gold mine for economic historians. The book of Alice Slotsky is a first attempt to edit and evaluate the material. Though her effort is valuable as a first attempt, a lot of work remains to be done. Her data are incomplete, her statistical analysis is defective and her disregard for the historical backgrounds hinders a fruitful use of the material. Hence it is the intention of the present reviewers to make a new edition of the Babylonian prices with a presentation of all equivalents with conversion into real prices and an adaptation to the Julian or Gregorian calendar, which may give an improved instrument for the study of economic history.

POSTSCRIPT (July 5, 2003)

Since completion of the above review, we have seen a new book on the Babylonian prices:

Péter Vargyas, *A History of Babylonian Prices in the First Millennium BC*. 1. *Prices of the Basic Commodities.* Heidelberger Studien zum alten Orient – Band 10. Heidelberger Orientverlag 2001.

It is the first of a series of four volumes. The present volume contains the prices (actually "exchange values – see below) of the main foodstuffs and wool as presented in the astronomical diaries. Volumes 2 and 3 will cover, respectively, the prices of other goods and immovables, and the available information on wages and slave prices. Volume 4 is planned to discuss general questions about the economy.

Vargyas' book is an improvement on the study of Slotsky for the following reasons:
1. Vargyas includes more prices. He has extended his research through the entire first millennium; he has taken all the data from the diaries, not just the end-of-month rates; he has included information from other sources.
2. Vargyas converts the Babylonian calendar into the Julian calendar, which is essential for the study of seasonal trends in the prices.
3. Vargyas' study of seasonal trends is methodologically sounder as he specifically investigates years for which we have enough data, a procedure we recommend in our review. He produces a long list of tables of equivalents for consecutive months. Contrary to Slotsky, he concludes that prices were subject to seasonal influence.

Vargyas' book, however, also has a few drawbacks:
1. What Vargyas call "prices" is actually the quantity of goods purchased for one shekel. The Akkadian word is *mahīru* (KI.LAM), which Hunger translated as "equivalent". We suggest to use the term "exchange value" which is close to the original meaning of the Akkadian word and which prevents confusion of concepts. Vargyas erroneous terminology has led to serious mistakes and the fact that the exchange values are not converted into real prices makes statistical analysis unreliable.
2. Real Statistical analysis is lacking
3. A conversion into Gregorian dates is to be preferred, since even in the Julian calendar the seasons slowly get out of step with the months.

Our first point is especially important, as we have already explained in our review above. The fact that Vargyas does not convert exchange values into real prices is likely to lead to errors. Since we are used to real prices, it is difficult to get our minds to think in exchange values. A couple of Tables provide clear illustration of the kind of error to which this can lead:
   In figure 29 Vargyas tries to show (correctly) that seasonal influences on prices can be detected. His procedure is as follows: he takes the 25 years for which we have summer prices (the time that the new barley harvest appeared on the market, and which he defines as the beginning of the "economic year") and also prices from the rest of the year (up to the year's end in the spring) which can be compared with them. His conclusion is that in 20 cases the prices did rise, as is expected in view of the fact that normally prices are low right after the harvest and tend to rise in the course of the year. His conclusions, however, would be much more convincing if he had not made the mistakes shown in our Table below. We give Vargyas' figures with our additions in grey shadow.

Figure 29.
Yearly change in the price of barley: the cheapest summer price compared to the highest price of the same economic year.

economic year	amounts (in litres) in summer	prices in shekels per 1000 summer	lowest amounts	highest prices	volume difference	price difference	yearly change in the price (Vargyas)	yearly change in the price (VdS/M)	factor
567-566	353	2.83	219	4.57	134	1.74	+38%	+61%	1.61
566-565	360	2.78	120	8.33	240	5.55	+67%	+200%	3.00
550-549	130	7.69	168	5.95	- 38	- 1.74	-29%	-23%	0.77
419-418	36	27.78	21	47.62	15	19.84	+42%	+71%	1.71
84-83	31.5	31.75	3.5	285.71	28	253.96	+90%	+800%	9.00

Vargyas' error is as follows: in year 567/6 there was a 38% decrease in the volume of barley purchased per shekel, which he simply converts from –38% into +38%, presumably because he realized that fewer litres per shekel means a higher price. But the rise in prices as a percentage of the previous sum is much more substantial. So Vargyas' conclusion that "the price of barley rose by an average of 37% during the years, if we disregard the years with falling prices" can be corrected to the advantage of his own theory: the prices in these 20 years actually rose by 120% on average, and even if one leaves out the extreme figure of year 84-83, the average increase was still 89%. If one takes into account that the highest prices presented here are the highest *recorded* prices (there is no year with a complete record of the prices), the actual highest prices must have been higher. So a rise by c. 100% (factor 2) is a fair guess, and this conforms to Vargyas' own expectations on the basis of loan contracts (p. 112-113; 117).

Vargyas makes the same kind of mistake in table 31, in which he compares "the prices in two consecutive (economic) years, or in other words the pre- and post-harvest prices (…) from the same calendar year. The percentages display the difference between the highest and lowest prices before and after the harvest, *as a proportion of the pre-harvest price*" (our italics). However, what Vargyas actually gives is the increase in volume of barley as a percentage of the *post*-harvest amount, and in this case he does not even turn the positive percentages into negative ones or vice versa.

Figure 31
The relationship between pre- and post-harvest prices

Year	Pre-h. (in litres)	Pre-h (in shekels per 1000 l.)	Post-h (in litres)	post-h (shekels)	Price diff. (shekel)	Price diff. Vargyas	Price diff. VdS/M	factor
567	180	5.56	353	2.83	2.73	96 %	-49 %	0.51
562	144	6.94	348	2.87	4.07	142%	-59%	0.41
325	9	111.11	45	22.22	88.89	400%	-80%	0.20
156	120	8.33	96	10.42	-2.09	-20%	+25%	1.25

Other tables, like fig. 30, show similar mistakes. Strangely enough, these mistakes are not made in tables where the prices of consecutive months are compared. These inconsistent errors, which we cannot explain, undermine the usefulness of his tables.

The tables in which the author compares consecutive months, and also beginnings and ends of months, reveal an interesting trend within single years. During autumn prices temporarily fell, which Vargyas correctly attributes to the arrival of the date harvest on the market (p. 127-128). There was also a dip in prices at the end of the economic year, as is indicated by table 36 (p. 121). Vargyas takes these data, which are rather thin, as evidence of a second harvest. As we have argued in our review of Slotsky's book, we de not believe in the existence of a second harvest, and we still do not. First of all, it is not very likely that a second harvest was held during the growing period of the main harvest. Second, we think that the slight fall in prices can easily be explained by the fact that the growing barley plants gave an indication of the potential coming harvest, which could be promising as was the case in 183 BC. That may have induced large organizations to empty their stores earlier than planned.

Much more can be said. It is clear that much interesting work is still to be done on the evaluation and interpretation of the Babylonian prices of the first millennium B.C.

RJvdS, CAM.

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