Climate, war and economic development: the case of Babylon

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Abstract

There is a lively debate on the causes of the price decline in the late Seleucid period. Less debate is there on the increase in prices during the early Parthian period which was supposedly caused by warfare and social unrest. In this paper we analyse the price decline and price increase together. We find that the decline is consistent with a supply shock. Climatic evidence suggests that during the Late Seleucid period climate was particularly favourable, which caused dates to decline faster than barley. This picture reversed in the early Parthian period. Did warfare and social unrest have any effect in the early Parthian period? Several papers have argued that market efficiency and per capita income did not change strongly during the Parthian period. Likewise, the literature also stresses a negative correlation between warfare and climate, making the impact of warfare on increased price levels less likely. Using a regression analysis, we find that wars and social unrest indeed did far less affect the price level in the Parthian period. This was not true, however, for the Seleucid period, once more confirming the negative link between climate and warfare.

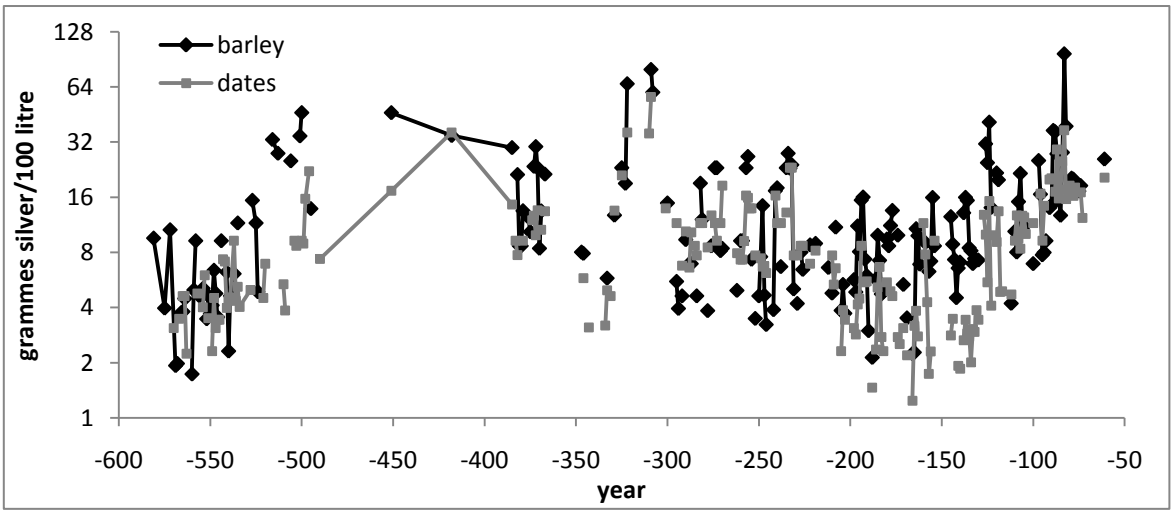
I

Economic development in Babylon during the Seleucid (330-141 BC) and Parthian (141-60 BC) periods has been a topic of research for quite some time. It has been argued that during the Parthian period, due to the unrest and wars, economic development stagnated. Yet, very little evidence has been found. For example, Foldvari and Van Leeuwen (2010) find no evidence for decreasing per capita incomes. Likewise, very little evidence has been found for reductions in trade, technological development, and decreasing consumption levels. For example, in the Sassanid period complex irrigation systems are found that supposedly partially originate from the Parthian times (Adams and Nissen 1972; Adams 1981). This suggests that the economy, and more specifically markets, were probably as efficient during the Parthian period as before

Indeed, Van Leeuwen, Foldvari, and Van Zanden (2011, this workshop), who define market efficiency as the possibility of the market to adapt to unexpected (i.e. exogenous) shocks, show that the Parthian period is not significantly different compared to the Seleucid period. Their explanation is that technology, trade, consumption, and storage do not significantly change over time and, hence, the ability of markets to respond does not change over time.

Yet, this is under the assumption that, in the long-run, exogenous shocks remain the same.

Figure 1: Barley and dates prices in Babylon (grammes of silver/100 litre)



Source: Slotsky (1997); Vargyas (2001); Slotsky and Wallenfels (2009); Jursa (2010); Van der Spek (2010).

This is consistent with the finding that prices of barley (and to a lesser extent dates) went down in the late Seleucid, early Parthian period (see Figure 1). After all, if economic shocks increased uncertainty and, hence, increased prices, a decline in prices between roughly 240 and 120 BC, suggests that exogenous shocks such as wars had relatively small effect on the over-all price level. Of course, the prices were not constant during this period of ca. 120 years: prices went down until ca. 170 BC and witnessed a minor increase afterwards until they reached the pre-240 BC level around 120 BC. Since the Parthian take over took place in 141 BC, this suggests that a rising trend in prices already started in the Late Seleucid period and therefore cannot be fully attributed to the Parthians.

The evidence of declining prices, relatively constant income as well as market integration rests uneasily with the view that during the Parthian period the exogenous shocks in terms of wars became more abundant. This will be discussed in the next Sections. In the next Section we study the low prices in the period ca. 240-120 BC. We find that this cannot be explained by demand shocks. Looking at the available evidence suggests that part of the explanation may be in improved climatic circumstances. The literature, however, suggests a negative correlation between climate and warfare: the better the climate the less warfare (Zhang et al. 2009). Therefore, in Section 3 we look at the wars and unrest at the start of the Parthian period. We find that they did not significantly increase volatility. We end with a brief conclusion.

II

In order to analyse the rise in prices during the Parthian period, it is also necessary to go into the reason for the decline in prices during the late Seleucid period. Therefore, we have to look at what is causing the decrease in price level in Babylon in the 2nd century BC. As pointed out above, market efficiency as found to be not substantially different in the Seleucid and Parthian period (Van Leeuwen *et al.* (2011 this workshop). Given that these regressions filter out country and time specific factors (i.e. explained volatility), this suggests that the decline in prices was caused by a factor that can be economically explained (hence no random shocks).

For the price decline in 2nd century Babylon several hypotheses are available. First, Aperghis argues this is a tax issue and the prices went down quite rapidly for dates and, relatedly, cuscuta.[1] A second hypothesis is brought forward by Van der Spek. He points out a royal law during the reign of Antiochus III (222-187BC) concerning the expansion of date gardens, which would have increased the relative supply of dates and, hence, reduced the price of dates relative to barley.[2] A third theory is that food production of especially barley went down because of increased salinization. Indeed, the previous 1000 years also witnessed salinization and a decrease in wheat yields. This salinization may have increased to a certain level when it affected barley stronger than it did dates.[3] A fourth theory is that the amount of silver in the economy reduced and, hence, that the purchasing power of the coins increased (Van der Spek et al 2011, this workshop). Finally, it has been argued that climatological factors affect the supply of both barley and dates. This last argument has also been brought forward for the 15th century AD where Zhang *et al.* argued for an increase in the average temperature and, hence increase in agricultural output.[4]

We can also make these arguments slightly more formal when placed in a simple demand-supply framework (see Figure 2 below). The curves *S* give the supply for barley and dates respectively, and *D* the supply. As figure 2 shows, the demand curve for dates is much steeper (less elastic) than that of barley. The reason is that dates are the inferior product (people will prefer more barley than dates when prices decrease).[5] This can be tested with present-day data from the food and agricultural society which present both prices and quantities of dates and barley. The price elasticity of demand can be written as

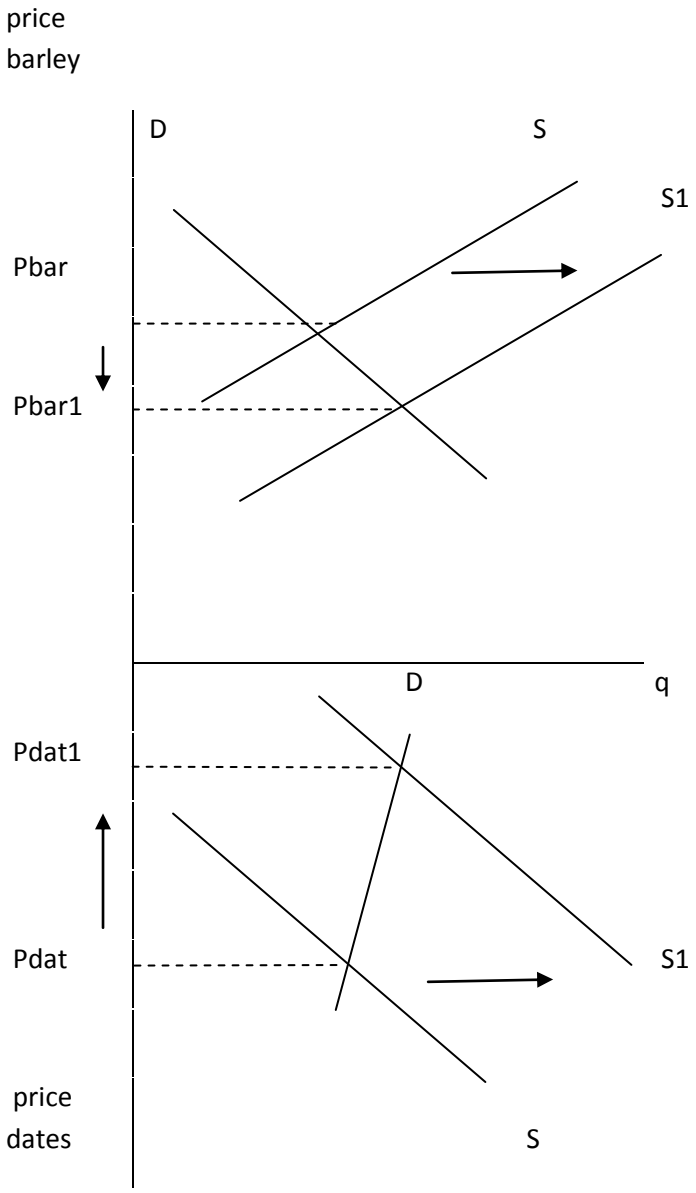
$$E_d = \frac{\Delta Q_d / Q_d}{\Delta P / P}$$

[1] Aperghis, *The Seleukid Royal Economy*, p. 84
[2] Van der Spek, "Palace, Temple and Market," p. 322.
[3] Jacobson and Adams, *Salt and silt*
[4] Zhang et al., "Global climate change," p. 19216.
[5] Jursa, *Aspects of the Economic History of Babylonia*, p. 464 argues, however, that dates is the elastic good. However, the higher the necessity, the lower the elasticity. Hence, since barley is more the luxurious good, one expects a lower elasticity for dates.

which says that the price elasticity of demand is equal to the % change in the quantity demanded divided by the % change in the price. Using the quantity and price data from the FAO for the period 1960-1990 for Iraq, we can calculate the price elasticity for dates as an average of Saudi Arabia, Qatar, and Yemen, all countries with dates and barley, as -0.6 for barley and -0.3 for dates.[6]

Above four hypotheses on price decline can be classified as a positive demand shock

Figure 2: supply and demand model barley and dates



[6] Of course these values have to be negative in order to get a demand equation. Furthermore, we did not distinguish between a demand and supply elasticity.

(lowering taxes), a negative supply shock (salinization), a positive supply shock (date gardens; climate). If there is a negative supply shock (salinization), the supply curve moves to the left, which increases prices, which is not true. If there is a positive demand shock (tax), the demand line will go to the right (for the same price more is demanded, assuming that consumers pay the price). This will however, increase product prices, which is counter intuitive. Likewise, if the supply curve goes to the right (with the same price, more is supplied), we find a decrease in prices, of which dates go down faster due to higher demand elasticity. This also applies to positive supply shocks for dates and climate. However, whereas the tax argument and the date garden argument only focus on dates, we found that also barley and (for Egypt) wheat prices went down in the 2nd century, suggesting that climate is the more appropriate argument. The final argument, only indirectly related to above demand and supply framework, is a decrease in silver in circulation in Babylon and, hence, an increase in purchasing power. Van der Spek *et al.* (2011, this workshop) found that a decrease in silver content will decrease the prices of dates more than of barley. However, even though a contraction is possible, we know from the Egyptian data (which had reverted to bronze coinage in this period) that a contraction had a smaller effect than can be seen in Babylon which actually never reverted to bronze coinage. Therefore, even though a contraction in silver in circulation certainly may have played a role, we expect climate to have had an additional effect.

Indeed, the climate scenario is often presented in the form of the relation between population, wars, and climate. For example Johnson and Gould (1984) argued that, in the case of Mesopotamia, they expected that in a climate with a drought, agricultural output would occasionally collapse, which would result in the population rising to a maximum where after a steep decline followed. In the case of a constant climate (and agricultural output), however, the population would rise to a maximum and, following the Malthusian logic in which populations only decline after a calamity, stay at that level.[7]

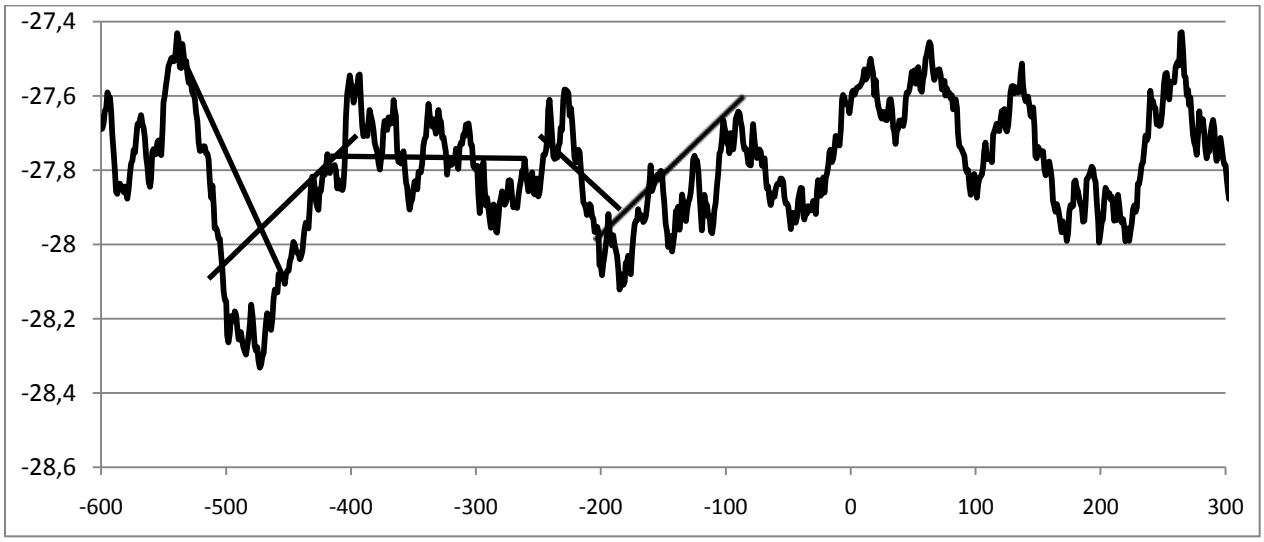
This thesis is difficult to substantiate for ancient economies in general. Fortunately, we do have some data to go deeper into this question. The most telling is the ice core data from Greenland, which is generally thought to be representative of the warmth development of the Northern

[7] Johnson and Gould, "The effect of climatic fluctuations," pp. 130-131.

hemisphere. The main idea is that temperature is affected by the oceans where the moisture evaporated that turned into snowfall on Greenland. This means that the lower the value in Figure 3, the colder the temperature was.[8] Since temperature is strongly related to agriculture (Zhang *et al*. 2007, Campbell *et al*. 2007), this has a direct bearing on agricultural output and, hence, prices. Indeed, Campbell, Kelly en Ó Gráda estimate for England that a 1 degree rise in summer temperature leads to a 5% increase in grain harvest.[9]

Remarkable spikes can be found in the ice core data. First, it is apparent that around 500 BC there was a strong drop in average temperature. This fits in quite nicely with the drop in

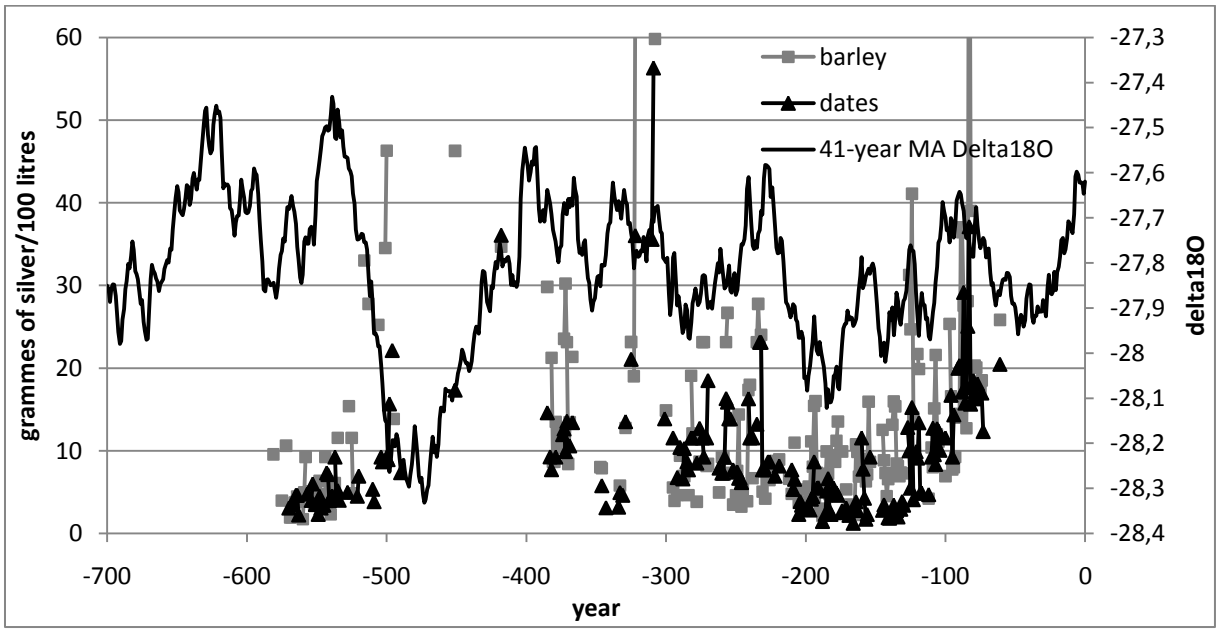
Figure 3: 41 year MA of Delta 18-o annual averages, 600 BC – AD 300



Source: Langway et al. "Greenland ice core."

[8] One caveat with these data is that before AD 700 they may have shifted 7 years. However, our analysis of price drops during two centuries will not be affected.
[9] Campbell, Kelly en Ó Gráda, "Weather, living standards, and population growth."

Figure 4: 41 year MA of Delta 18-o annual averages versus \barley and dates prices (grammes of silver/100 litre), 700 BC – AD 1



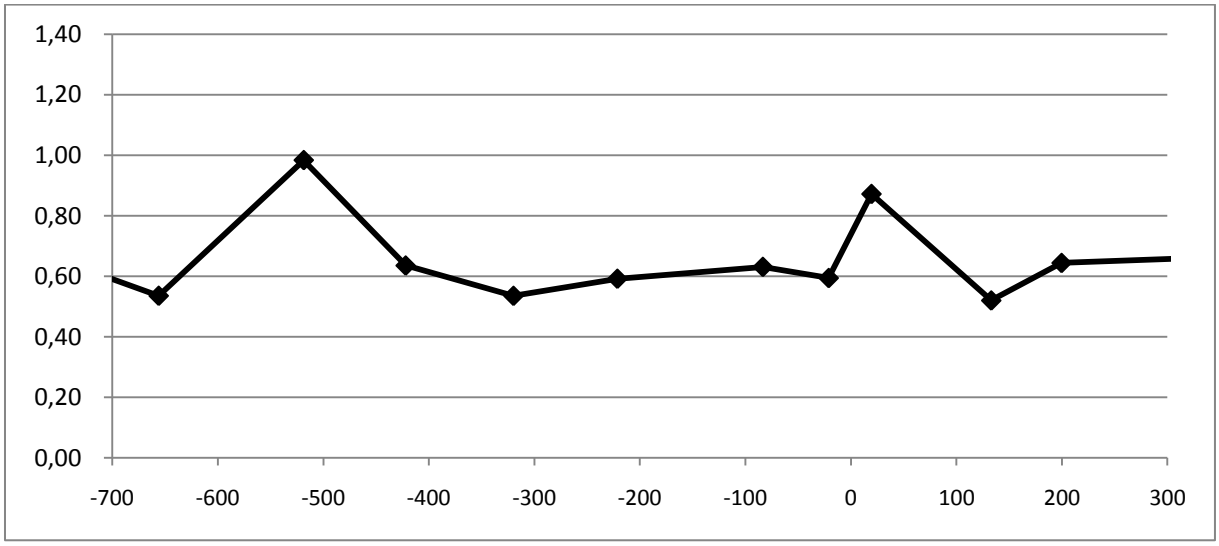
prices of barley and dates in Babylon around this period as shown in Figures 1 and 4. The increase in prices just after 500 BC again corresponds with an increase in average temperature. Between ca. 400 and 280 BC we find a small decline in temperature, which corresponds with a small decline in the average price level, followed by an increase in both temperature and prices up to ca. 230 BC. Between ca. 230 and 180 BC we find a strong decrease in both prices and temperature, which increased in tandem again after 180 BC until ca. 80 BC. Unfortunately, we have very little data beyond that point, but the temporary decline in temperature afterwards suggests more abundant harvests and a temporary decline in prices.

It thus appears there is a positive correlation between the ice core temperatures in Greenland and the average price level in Babylon. This may sound counter-intuitive, but it may have induced more rains, benefitting growth in warmer regions such as Babylonia. Indeed, it is quite a disadvantage that the ice core data are considered representative for the Northern hemisphere as a whole. However, if a correlation between climate, agriculture and war actually exists, it must also be visible in more local

data. For Babylon we have trees and shrubs values from Lake Van, a lake in South-eastern Turkey which is thought to be representative of the climate in the Near East in general.[10] If we divide the graminae (which thrive in wet weather) by the non-arboreal pollen (which thrive in dry weather), we have an index of moisture (see Figure 5).[11]

Unfortunately, the data points are only available for selected periods. Yet, it is perfectly clear that around 500 BC (when we know there was a cooling down) the weather was also considerably

Figure 5: Gramineae/NAP, 700BC-AD300



Source: Wick et al (2003)

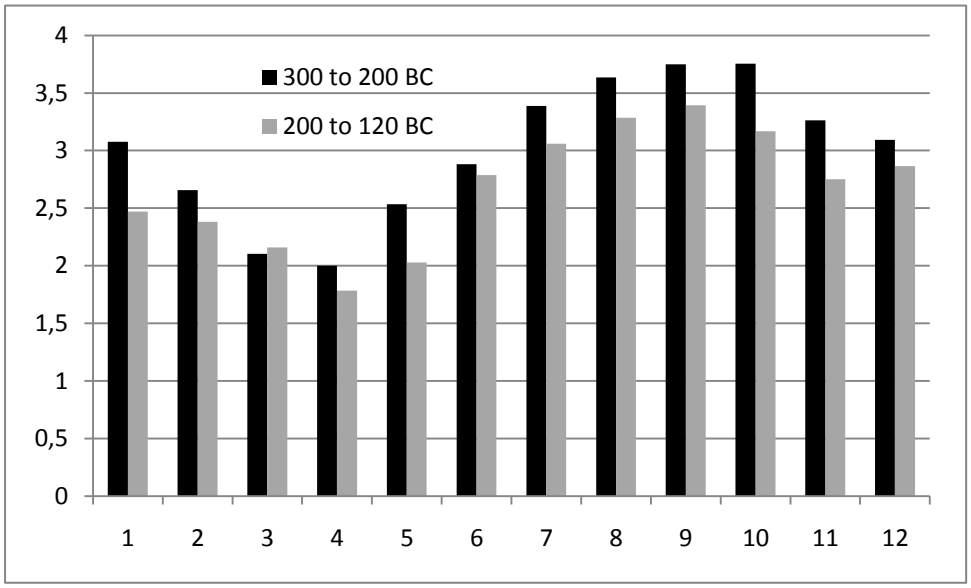
wetter. This combination of cool and wet weather is not as clear everywhere though, even though there is a slight upward drift until ca. 100 BC. Yet, the cooling down in that period is also less pronounced as in the period around 500 BC. We also find a clear increase in moisture around AD 40 which, as we know, is also a period of strong cooling down. Hence, it is clear that periods of cooling down in Babylon are accompanied by increased moisture. [12]

[10] Wick *et al.*,"Evidence of Lateglacial and Holocene climatic change."
[11] El-Moslimany, "Ecological significance of common nonarboreal pollen," p. 347.
[12] The ratio of Graminae to non-arboreal pollen is also indicative of forestation. As pointed out by El Moslimany (p.348), this ratio is indicative of both the percentage of non-arboreal pollen (which is high in Iraq, suggesting a dry climate) and the level of forestation (which given this ratio must be very low).

The ratio of Graminae to non-arboreal pollen is also indicative of forestation. As pointed out by El Moslimany, this ratio is indicative of both the percentage of non-arboreal pollen (which is high in Iraq, suggesting a dry climate) and the level of forestation (which given this ratio must be very low).[13] That the land was dry is not strange since Babylon, as was also the case in Egypt, was in essence a region that dependent largely on irrigation. Both Babylon and Egypt were heavily dependent on their main rivers, the Euphrates and the Nile respectively. Fortunately, we have data on the maximum and minimum annual water levels for both the Euphrates and the Nile river.[14] The Nile is given in the difference between the highest and the lowest level, in a year. However, in the Astronomical diaries, which contain monthly notations of the river level, the Euphrates is given in *na*, the distance (by us converted into metres) from the peak level downwards, so that a high *na* means a low water level. As below Figure shows, it seems that the highest water level was around April, and the lowest around September.

Figure 6: Monthly river level of the Euphrates between 300-200 and 200-120 BC in Na

(the higher the Na, the lower the water level)

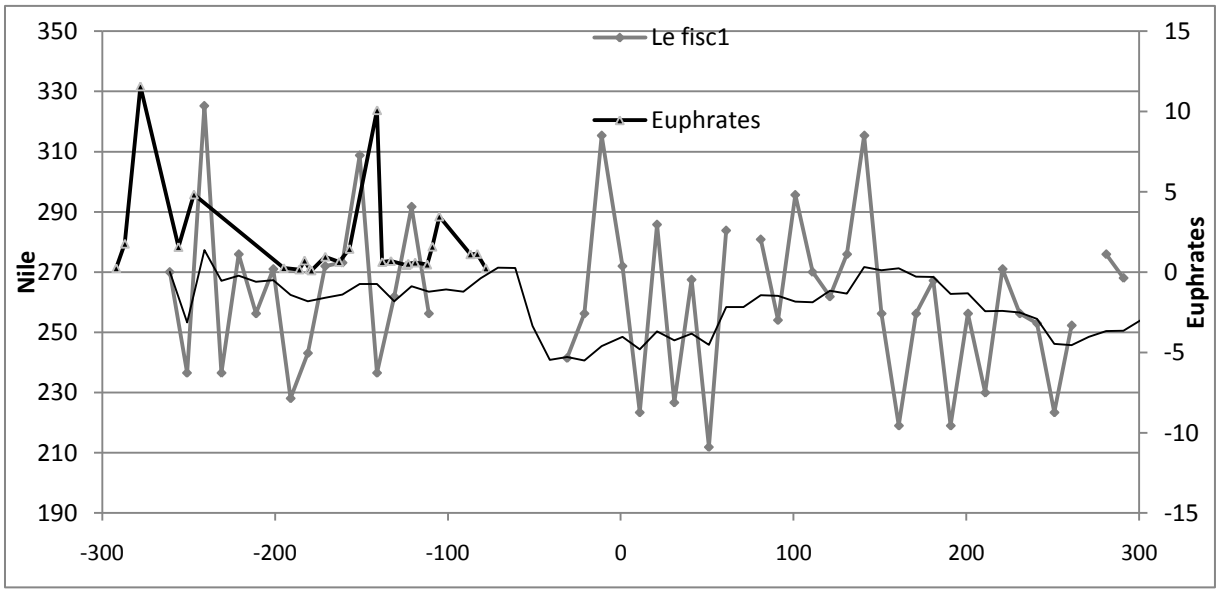


[13] Idem, p. 348.
[14] Popper, *The Cairo Nilometer*; Bonneau, *Le fisc et le Nil.*

As one can see in Figure 6, it is clear that the level of the river was higher in the period between ca. 200 and 120 BC, when we also found that temperature went down and moisture was increasing.

It may be useful to make this test over time for both the Euphrates and the Nile. The Nile data can be obtained directly from the literature, however for the Euphrates we need to make some adaptations. As can be seen from Figure 6, the highest level of the Euphrates is attained in month 4 (April) and the lowest in month 9 (September). We therefore want to calculate the difference in water level between April and September. However, we have a chronic lack of data. Therefore, we also include the months March and May for the highest, and the months August and October for the lowest water levels. The water levels of these extra months are corrected using the monthly differences from Figure 6. This results in a maximum annual water level fluctuation for the Euphrates which, together

Figure 7: Index of maximum annual fluctuations of the Nile and Euphrates rivers



Source: Bonneau (1971), This text

with the Nile, is reported in Figure 7 below. There are a few noteworthy points. First, even though we cannot directly compare because of lack of data, we can see that some of the outliers are remarkably similar. Most notably, in 247 BC and around 151 BC there is a strong outlier in the water level in both

the Nile and the Euphrates. More importantly, though using an independent test, it showed that the average water level was higher in the 2nd century BC.

All in all it seems that there is plenty of evidence that there were climatic changes in the 2nd century BC Babylon. It was characterized by lower temperatures and increased moisture as appears both from our gramineae/NAP index and from the increased level of the Euphrates river. Increasing water levels must have increased the agricultural output of barley and dates which, given the inelastic nature of dates demand, leads to a higher price drop in dates than barley.

III

The hypothesis in the literature has been so far that the increase in prices during the early Parthian period is caused by increased unrest and warfare. This assumption of unrest and warfare causing massive price rises, however, does not match with findings in the literature of a constant per capita income and constant market efficiency. Given that we found an improvement in climate, neither does it match with theories outlined before, that argue that an improvement in weather circumstances increased agricultural output and reduced warfare (Zhang et al 2007). Clearly, climate was deteriorating again after 180 BC, but the pre-Parthian levels of climate would only be reached around 100 BC, well after the start of Parthian rule.

To test the effect of wars, we regress the growth of prices on a month dummy and a dummy indicating war inside Babylon. Further, we included a first difference of dates prices since the increase of dates prices may also influence the price change in barley. Finally, we included the *na* (in meters) since the river level may affect the growth of prices as well. Table 1 reports the results for the period ca. 350-100 BC. It is clear that there is a strong seasonal effect. Furthermore, an increase in the price of dates has a positive effect on the increase in the price of barley. More interesting though, is that the

Table 1: regression of barley, 350-100BC

```
. xi: reg d.lnbarley i.month i.monthwarinsidebabylon d.lndates nameters if year>-
                                > 350 & year<-100
   i.month           _Imonth_1-12        (naturally coded; _Imonth_1 omitted)
 i.monthwarins~n     _Imonthwari_0-1     (naturally coded; _Imonthwari_0 omitted)

      Source |       SS       df       MS              Number of obs =      57
-------------+------------------------------           F( 14,    42) =    2.69
       Model |  .894159561    14   .06386854           Prob > F      =  0.0068
    Residual |  .998976608    42  .023785157           R-squared     =  0.4723
-------------+------------------------------           Adj R-squared =  0.2964
       Total |  1.89313617    56  .033806003           Root MSE      =  .15422

------------------------------------------------------------------------------
  D.lnbarley |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    _Imonth_2 |   .2496655   .1146474     2.18   0.035     .0182976    .4810333
    _Imonth_3 |   .3600821   .1212281     2.97   0.005     .1154339    .6047304
    _Imonth_4 |   .3201102   .1193477     2.68   0.010     .0792568    .5609635
    _Imonth_5 |   .1096169   .1100174     1.00   0.325    -.1124073    .3316411
    _Imonth_6 |   .1947668   .1219163     1.60   0.118    -.0512702    .4408037
    _Imonth_7 |   .4604339   .1439296     3.20   0.003     .1699721    .7508957
    _Imonth_8 |   .0884801   .1198563     0.74   0.464    -.1533996    .3303599
    _Imonth_9 |   .3100504    .112866     2.75   0.009     .0822775    .5378233
   _Imonth_10 |    .240984   .1076611     2.24   0.031     .0237152    .4582528
   _Imonth_11 |   .3457631     .12307     2.81   0.008     .0973978    .5941283
   _Imonth_12 |   .3601822    .110382     3.26   0.002     .1374222    .5829422
War in Babylon|   .1333464    .064534     2.07   0.045     .0031115    .2635813
                                       |
                                lndates |
          D1. |   .4668734   .1785848     2.61   0.012     .1064746    .8272721
                                       |
     nameters |   .0580153   .0460761     1.26   0.215    -.0349701    .1510007
        _cons |  -.4084385   .1297335    -3.15   0.003    -.6702512   -.1466258
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effect of a war on a price increase is clearly positive and significant with a coefficient of 0.13.

The same regression, now for the period 150-50BC, is reported in Table 2. It is interesting that the positive effect of a price change of dates on a price change of barley remains the same. However, the variable "*na* in meters" becomes positive and significant, suggesting that an increase in the river level lowers the prices, which is exactly what we argued in the previous section. Finally, we find that the effect of war is not significant.

The preliminary conclusion therefore seems to be that only during the Seleucid period we find a strong effect of war on prices. This was also the period with less moisture and lower temperatures,

Table 2: regression of barley, 350-100BC

```
. xi: reg d.lnbarley i.month i.monthwarinsidebabylon d.lndates nameters if year>-
                                                > 150
  i.month           _Imonth_1-12        (naturally coded; _Imonth_1 omitted)
i.monthwarins~n   _Imonthwari_0-1     (naturally coded; _Imonthwari_0 omitted)

      Source |       SS       df       MS              Number of obs =      46
-------------+------------------------------           F( 14,    31) =    3.45
       Model |   .75819759    14  .054156971           Prob > F      =  0.0020
    Residual |  .486750162    31  .015701618           R-squared     =  0.6090
-------------+------------------------------           Adj R-squared =  0.4324
       Total |  1.24494775    45  .027665506           Root MSE      =  .12531

------------------------------------------------------------------------------
  D.lnbarley |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   _Imonth_2 |  -.0484721   .0887974    -0.55   0.589    -.2295755    .1326313
   _Imonth_3 |   .0190787    .097164     0.20   0.846    -.1790886    .2172459
   _Imonth_4 |   -.067424   .1043816    -0.65   0.523    -.2803118    .1454638
   _Imonth_5 |  -.1667386   .0879319    -1.90   0.067     -.346077    .0125997
   _Imonth_6 |  -.0495081   .0950626    -0.52   0.606    -.2433895    .1443734
   _Imonth_7 |   .1321429   .1072887     1.23   0.227    -.0866739    .3509597
   _Imonth_8 |  -.0749212   .0871036    -0.86   0.396    -.2525702    .1027277
   _Imonth_9 |   .0142283   .1024419     0.14   0.890    -.1947034      .22316
  _Imonth_10 |   .0343657    .099296     0.35   0.732    -.1681498    .2368811
  _Imonth_11 |  -.0117544    .120515    -0.10   0.923    -.2575463    .2340376
  _Imonth_12 |   .1937252   .0903087     2.15   0.040     .0095394     .377911
War in babylon|  -.0142105   .0507539    -0.28   0.781    -.1177239    .0893028
                                                |
                                      lndates |
          D1. |   .3563868   .1626124     2.19   0.036     .0247367     .688037
                                                |
     nameters |   .0547492   .0295166     1.85   0.073    -.0054503    .1149487
        _cons |  -.0924506   .0851139    -1.09   0.286    -.2660416    .0811403
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causing less agricultural output. This matches well with the theories that connect climate with agricultural output and warfare. For the early Parthian period, we find that climate has a strong effect on prices: the higher the river level (and moisture), the higher the agricultural output. In agreement with the climate-agricultural output-war theory, we also find no significant effect of war on the price levels.

IV

A. Introduction

Can we substantiate the claim of decreasing effect of war on prices in the mid-2nd century based on contemporary historical evidence? If warfare has hardly or no significant influence on price developments for the years 150-100 BC, we would expect that during that period, warfare would take

place less often and/or would be of smaller scale than in times preceding and succeeding this specific time span. Would our main historical source, the Babylonian astronomical diaries, support this proposition? We will compare some cases of warfare from within and after the time frame 150-100 BC with price developments at that time. Hence, in the next sub-sections we will look at the nature of the conflict (large scale warfare such as invasions and pitched battles versus warfare that may have conducted by fewer people, like minor operations, raids and rebellion), How they affected barley prices, and most importantly, how these changed over the different time periods.

B. The period between 150 and 100 BC

1. Pitched battles& occupations

The first clear pitched battle that we encounter is the first attempt of the Seleucids to reconquer their

Table 3: Prices in grams of silver per 1000 l., 139-137 BC

Price in grams of silver per 1000 l.		Barley	Dates	*Kasû*	Cress	Sesame
Date	Event	1000 l.	1000 l.	1000 l.	1000 l.	1000 l.
Beginning of 140		73	19	16	208	309
Summer 139	- Start Seleucid campaign - Parthian war vs. Elam	107		11	231 > 555	
Autumn 139	- Seleucid successes - Parthia vs. Elam	105 > 146	29	11	327 > 417	505> 555
Winter 139/8		154 > 160	33 > 29	12	463 > 417	504 > 555
Spring 138	Operations in Babylonia	155 > 96	29 > 28	15		520 > 666
Summer 138	Decisive battle Seleucids vs Parthia	99 > 115 > 111 > 115	25 > 26	19 > 15	463	695 > 877
Autumn 138	Again fights vs. Elam	126 > 154	28	12 > 13	695	926
Winter 138/7	Elamite invasion; Mesenian intervention	174 > 154 > 163	23 > 42	12	641	1041 > 926
Spring 137		198 > 194 > 198	46 > 38 > 40	15	1190 > 595	1041
Summer 137		198 > 154 > 191	51	15 > 13	595 > 416	

lost territory in Mesopotamia, in 139/8 BC.[15]

Table 3 shows clearly that in the month of the battle, the barley price remains unchanged and the rather constant date price even shows a dip. In the months before and after the battle, the barley prices seem to fit the yearly pattern of low prices after the harvest in spring and higher prices closer to the next harvest. The high cress price is likely to be part of a continuous increase already set in during summer 139 BC, to culminate in April 137 BC. Only *kasû* (cuscuta) and sesame show a clear price increase, although also the sesame price forms part of a general in increase between October 139 and December 138 BC.

The more marked price rises – compared to the directly preceding years – have taken place long before both kings meet, i.e. in summer and autumn 139 BC (for all foodstuffs but dates) and later in winter 137 BC (for all, but for barley only slightly). It takes until 135 BC before the prices are back on the level from before the summer of 139 BC. It is striking that at the beginning *and* some time after the pitched battle between the protagonists, prices rise strongest and highest, while at the battle itself the effect is not as clear as expected.

Let us compare this with a later conflict, the Parthian reconquest of Babylonia after it had been occupied for a few months by Hyspaosines, king of Mesene (= marshy far South of Babylonia) in June/July 127 BC.[16] Between mid-October 128 and May 127 BC, Hyspaonines of Mesene conquers Babylonia. Within a month the moderate date price rise 40%. In May-July, when Parthia expels the Mesenians again, the date price is extremely high and 4.5 times as high as half a year before. Also the barley price will have been relatively high now, regarding the succeeding level. The reconquest cannot have taken much time; we might even presume a pitched battle. The conflict for Babylonia influenced

[15] AD -137A and D; furthermore (among others) 1Macc 14.2-3; Diod 33.28.1.
[16] For the latter see AD -126A, -126B, -125A 19/20, -124B r14'-r16'; BOR IV.7 p131-44: Del Monte 1997, 113-6; CT 49.149.2; Trog. *Prol* 42.; Van der Spek 1985, 548-51; Assar 2006a, 107+115: S18.1 overstruck.

Table 4: Prices in grams of silver per 1000 l., 128/7 BC

Price in grams of silver per 1000 l.		Barley	Dates	Sesame
Date	Event	1000 l.	1000 l.	1000 l.
November 129			38	
November 128	Start Mesenian conquest		103 > 139	
End May / June 127	Start Parthian reconquest		463	
June/July 127	Fighting	278		
Sept / End Oct 127	Parthian king dies in the east; new king is probably in the west	347		
November 127	Parthian troops in Babylonia		99 > 92 > 116	1149
Winter 127			252 > 555	
March 127		417 > 347	185	

price levels, although fighting resumed in spring, and – regarding the prices in winter – maybe even not have stopped completely.

2.Possibly smaller operations

An example of small incursions are the raids for booty by the Arabs from 130 BC until the end of the second century. Below we present a few text passages compared to the accompanying price levels when preserved.[17]

In 125/4 BC we see the contrast of the effect between Arab incursions, even when they follow each other quickly. In 124 BC the high prices of the Parthian winter-war extend far into summer, for which only the presence of the Arabs seems to serve as an explanation. Especially the barley prices of May are extraordinary high. The reason for a sharp decline in prices of barley (and sesame), in a month that the barley is already harvested long ago, is completely unclear. Note also the moderate barley and date

[17] AD -124A, -124B, -123A and -118A

Table 5: Prices in grams of silver per 1000 l., August 125 – August 124 BC

	Price in grams of silver per 1000 l.	Barley	Dates	Sesame
Year	Event	1000 l.	1000 l.	1000 l.
August 125	The Arab breaks through the wall next to the Zababa Gate; [traffic?] cut off because of Arabs; Arabs bought off as before	219	51	
Dec/Jan 125/4	- Parthian king defeats Elam in battle - Arabs plunder as before→ panic	406 > 416 > 406	79 > 75	876 > 833
Jan/Feb 124	Arabs plunder as before	406 > 555 > 521	69 > 99 > 92	926 > 901 > 1041
May 124	Arabs bought off as before; [traffic?] cut off because of Arabs	(438 >) 926 > 877		
August 124	- Arab plundering as before - Internal[?] battle	264 > 256	163 (> 201)	740
Oct/Nov 119	Arabs hostile as before and plunder	147 > 134	137 > 139	

prices when the Arabs break through the walls of Babylon a year before. Perhaps the fact that traffic was cut off in May 124 was extra handicap (but it also happened in August 125) and one might wonder what the effect was of buying off the Arabs (but that also happened in August 125). Another example of the latter is the year 119 BC.

C. The period 100-61 BC

1. Pitched battles & occupations

The only two clearly defined pitched battles (in open field) that have come to us are two battles from outside Babylonia.[18] Therefore, it seems better to look at the effects of sieges instead. We find two possible occasions, with different effects. In the first case results a siege (of Susa) in (slight)

[18] AD -87C and -77B. The might have had some influence on price developments within the province, but it seems to be limited. Prices are high but we cannot discern a sharp rise. More important. at both occasions homeland affairs very well may have played a role too.

Table 6: Prices in grams of silver per 1000 l., 91/0 and 84-82 BC

Price in grams of silver per 1000 l.		Barley	Dates	*Kasû*	Cress	Sesame
Date	Event	1000 l.	1000 l.	1000 l.	1000 l.	1000 l.
Dec 91 / Jan 90	- Chief general departs from other Tigris bank, (probably to) the surroundings of Susa - Reduction of the equivalent in Susa (his siege?)	154 > 160 > 138				926 > 793
July/Aug 84	*Chief stratēgos* Mithrates [departs?] with many troops from X to the city of Y; '(out of) fear the city gates [were closed]'	290	252			
April 83	Revolt in Uruk	1282 > 1388 > 2380[19]	438	31		
26 Sep – 17 Oct 83	- threats? as before - killing; carrying; people move back to their cities	cut off			1111	1111
18-25 Oct 83	- *Politai* … in fear of Alexander to? … leave for Seleukeia	659[20]			1111	1111
Dec 83 – Jan 82	- *Stratēgos* of Babylonia leaves for [Babylon/Seleucia?] and [attacks] with battle equipment the city gates - pillaging/surrounding above & below B.	463 > 438	170 > 154	31		
Mar/Apr 82	(- in fear of the *politai*…) (- king nearby)	267[21]	162			

price decreases in Babylon (barley is rather cheap; sesame of moderate price)[22]. In the second occurrence it forms the last part of the year with the highest barley prices of the Parthian period (April 83/2 BC).[23]

Notwithstanding the very high prices, barley and dates are decreasing in price when the siege takes place. Thus it cannot be viewed separate from the other internal warfare during this year; it is not decisive. Moreover, in non-Babylonian sources it is said that the Parthian vassal kingdom of Armenia

[19] Barley 'cut off'; price concerns barley 'on the way'.
[20] [Before 18 October] no supply ('cut off').
[21] 'in the afternoon'
[22] AD -90
[23] AD -82A and -82B

freed itself in defeating the Parthians around this time and conquering Northern Mesopotamia.[24] In the same period, the Jewish state campaigned outside Judaea for 3 years.[25] Note that the extreme price (3.5 litre for a shekel) is noted for "barley on the road", which implies the dependence of at least the city of Babylon on regional trade for its barley-supply.

The diaries attest military activities of Mitratu (Mithrates), the chief commander of troops, in the region of Seleucia and Babylon from 91 to 84 BC. This general was not only present in a garrison or to levy troops, but there was fighting as well. One might consider that this general was in fact acting on his own as a rebel.

2.Possibly smaller operations

The occurrence of Mitratu as a possible rebel blurs the difference we try to maintain between smaller and bigger conflicts, as he is mentioned in many smaller (as it seems) operations after 91 BC.[26] Like

Table 7: Prices in grams of silver per 1000 l., impact small warfare after 100 BC

	Price in grams of silver per 1000 l.	Barley	Dates	Cress	Sesame
Year	**Event**	1000 l.	1000 l.	1000 l.	1000 l.
Dec 100	Troop movements (& mustering)	69	116	96	438
Aug/Sep 96	Refugees & unhappiness; Armenian crown prince …	159			694 (> 653)
May/June 87	(Native) Babylonians attacked	208			
Nov/Dec 91	Accession Parthian Gotarzes I; chief general departs from other side Tigris 'to his place'		194 > 231		740 > 833
Dec 89 / Jan 88	Civil unrest / rebellion	370			(1111)
Feb 77	[Babylonians and(?)] Greek citizens fight against each other inside temple area		174 > 185		

[24] AD -95C 6', -95D 10'-11'; furthermore among others Strab 11.532b, 14.669b, 16.745c; Joseph. *AJ* 13.371, 419; App. *Syr* 48b, 69c,70a; *Mith* 106b; IsidChar 2e. Cf. Schippmann 1980, 32-3; *CHI III.1*, 40-1 and Assar 2006b, 73.
[25] Joseph. *BJ*_1.105, *AJ*_13.394-397,* 14.18
[26] He might have had his own territory, cf. AD -90 32': "Chief stratègos Mithrates departs from other side of Tigris 'to his place' "; cf. AD -86A 'sat on his throne'.

with the Arabs, ‘smaller’ operations may have had irregular effects, although maybe a bit more regular than in the 120s. Especially sesame shows high prices and sharp increases during this time span. Below first the smaller effects, then the bigger ones.

D. Amount of occasions of warfare compared: 141-100 BC vs 100-61 BC

The accounts in the astronomical diaries about the years 141-100 BC are more complete and also more abundantly preserved than those about the time span 100-61 BC. Thus, one gets rather easily the impression of Parthian Babylonia as a province of an empire in decline, right from the start in 141 BC. The, in the long run, rising prices have contributed to that. Therefore it could be sensible to check the matter roughly, by giving a closer look into the distribution of the text passages which contain warfare, over the total amount of text passages in the diaries. Because the historical sections in the source are organized by month, we have counted the amount of monthly text passages containing warfare, related to the total amount of preserved text passages in a year. The distribution is given first excluding fragments with only prices, and then including the latter. The reign of the Parthian king Mithradates II, who ruled in both periods (121-91 BC), is also included, as a whole and divided by periods.

Table 8: Warfare records as percentage of astronomical diaries, 141-61 BC

Period	Warfare mentioned	Total historical sections	% 1 Warfare	All sections	% 2 Warfare	
141-101 BC	81	122	66	132	61	
100-61 BC	33	44	75	60	55	
120-91 BC	31	48	65	58	53	
120-101	20	37	54	40	50	
100-61	11	11	100	18	61	

The two ways of measuring create two contrary results. If we follow method 1, it is to be expected that the original recordings contained more warfare for the period after 100 BC, which would fit our

argumentation. In using method 1, we find that warfare occurred more during the years before 100 BC, which would contradict our statements – although the difference in percentage would be lower. As it is difficult to make a pronouncement on the intensity of the warfare, as we have seen above, that won't help us here. Anyhow, it cannot function as a strong argument against our statements either.

E. Summary and conclusion of the historical paragraph

Summarizing the yield of the historical evidence, the impact of warfare on the price development of basic foodstuff in Parthian Babylon is not abundantly clear. We cannot explain, nor predict, which kind of warfare has what kind of effect of the height of the prices. In some situations, battles, sieges, raids and troop movements are likely to exercise influence on price levels. In other, seemingly comparable situations though, they appear to have no considerable effect. The conclusion which we nevertheless may draw, is that at certain moments during Parthian rule, the ability of the Babylonian economy to endure ongoing warfare of any kind, reaches its verge. Alas, the reason why a limit is being reached at those moments, is still to be explained. The distribution of warfare over our main source shows that a strong decline of Parthian Babylonia, from its conquest onwards, is anyhow not discernable. Thus we cannot, as for now, strongly support with positive evidence the finding above, that the effect of warfare on prices in the Parthian period is smaller than in Seleucid times. However, we cannot reject it either. The irregularities in the historical evidence, 'negative' evidence as you wish, nevertheless points slightly into the direction 'no significant influence'.

V

In this paper we discuss the price decline in the late Seleucid, and the following price increase in the early Parthian, period. Looking at the price increase, it has been argued in the literature that this is partly caused by an increase in warfare and unrest inside Babylon. In this paper we analyse this argument by looking at the price decline- and increase in tandem.

Looking at a simple demand and supply model suggests these the decline in prices during the Parthian period is caused by increasing supply of the main staple crops. This also explains why dates prices in Babylon declined more than barley prices: given the inelastic nature of the demand for dates, an increase in the supply of barley and dates results in a faster decrease of dates, than barley prices. But what can explain this supply shock, which also took place in Egypt at the same time? We find that the second century BC was characterized by cool periods. These cool periods, were accompanied by increased moisture, as appears from an analysis of the data of Lake Van in South-eastern Turkey. Likewise, we find that the river level of the Euphrates increased in the 2nd century BC.

Hence, the cooling down combined with increased availability of water enhanced the growing of barley and dates. According to climate theory, a better climate would induce a better harvest and less warfare. Since climate was less warm during the late Seleucid period, we expected that wars have the effect of increasing the price level. Likewise, during the Parthian period, with favourable climatic circumstances, this theory predicts that wars, if any, have little effect on the price level. Using a regression analysis for the Seleucid period, we indeed find that war inside Babylon increases prices. For the Parthian period, however, we find that an increase in the river level positively affected the growth of barley, but that the effect of wars was insignificant thus confirming climate theory.
The historical sections of our sources that we have given a closer look, do support in a certain way the finding above, that the effect of warfare on prices in the Parthian period is smaller than in Seleucid times (e.g. Pirngruber, this conference): the different kinds of warfare have irregular and unpredictable effects on price developments in the Parthian era and their distribution over the sources does not contradict us. This is maybe not a very strong support; however, it does not reject our conclusion either.

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