Quantifying the integration of the Babylonian economy in the Mediterranean world using a new corpus of price data, 400-50 BC.

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1. Introduction

Since the work of Persson (1999), market efficiency has gained attention once more. Most studies focus on the medieval and early modern period, where the often heard argument is that higher market integration leads to more efficiency and better economic development.[1] This argument has made many scholars of medieval and ancient economies aware of the importance of market institutions. It is therefore not strange that an increasing number of publications have been appearing that confirm the existence of market behaviour in medieval and ancient economies.[2] Indeed, as pointed out by Andreau (2002), the primitivist, Finleyan, way of thinking has almost completely been abandoned nowadays.

But the mere existence of markets does not say much about their efficiency. Market efficiency, broadly defined as the capacity of the market to deal with external demand – or supply shocks, is often equated with trade. Indeed, a well developed transport network makes it possible to transport grain to places with the highest prices, hence smoothing price fluctuations. Hence, if price volatility is low, it is a sign that markets can deal with external shocks.

For the ancient world in the heyday of the Roman Empire, it has often been argued that Rome was at the centre of the grain trade in the Mediterranean. For example Kessler and Temin (2005: 2) have argued that, in the Roman Empire, there must have been extensive trade

[1] cf. e.g. Studer 2008: 395.

[2] Britnell and Campbell 1995; Temin 2002; Rathbone 2009; Van der Spek 2006; Földvári and Van Leeuwen, in press).

relations. They based their conclusion on the observation that the further the distance from Rome was, the lower the prices were. The price difference they explain from transport costs.

Few studies, though, have looked at this question for the second largest empire: the Seleucid and its successor, the Parthian Empire. In this paper we assess if the same effect of trade and market efficiency applies to Babylon, being a city in the Seleucid and then, from 141 BC, the Parthian Empire with abundant price data. In the next section, we discuss the data and measurement issues. Section 3 discusses the market integration in Babylon and the Mediterranean world. Since the (non-)existence of trade relations has an effect on the adaptation of markets to external shocks, we turn in Section 4 to the consequences for price volatility. Yet, the existence of shocks is only half the story since trade does not necessarily only limit the number of times high prices occur, but also their duration. Hence, in Section 5 we have a closer look at the duration of high prices. We end with a brief conclusion.

2. The data: problems of metrology and methodology

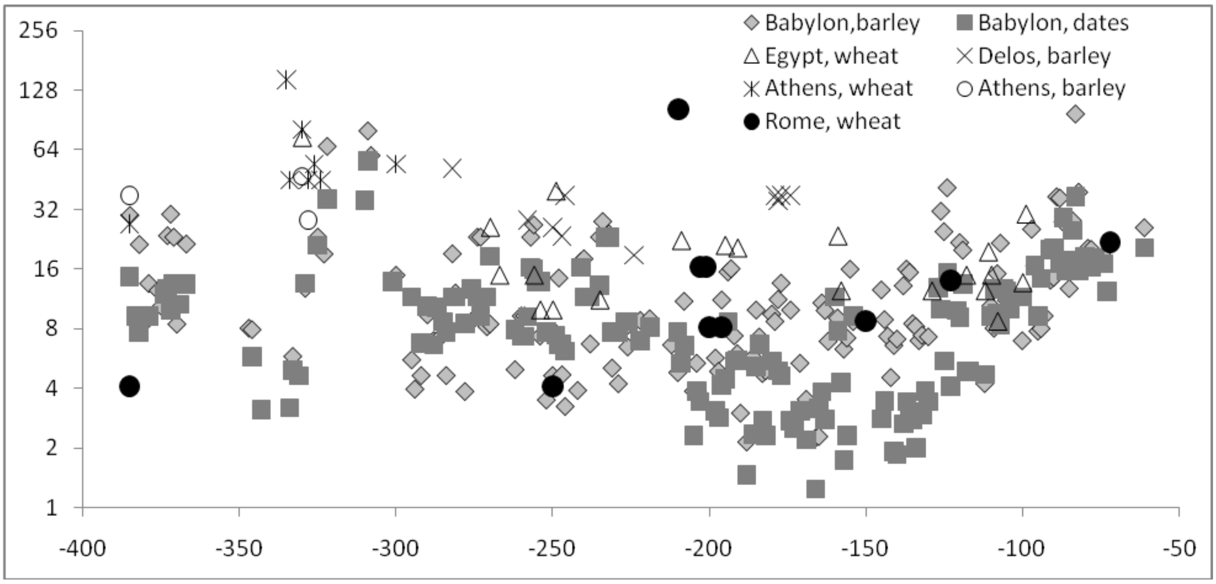
The main data-set consists of a large set of prices of Babylonian commodities. First millennium Babylonia has produced a data-set of prices which has no equivalent in the ancient world. For the Hellenistic period (from 331 BC to 30 BC) a rich source of price data is contained in so-called Astronomical Diaries from the city of Babylon. These diaries contain a notation of celestial phenomena followed (to an increasing degree over time) by information on other events like monstrous births, direction of the wind, the weather, the level of the Euphrates, deeds of kings, important events in Babylon and the level of the prices of six commodities: barley, dates, cuscuta, water cress, sesame and wool. These diaries probably constituted a database for astrological research, a database of possible connections between phenomena in the sky and events on earth. A new source of documentation has recently become available by the publication of eighteen clay tablets containing price lists of the same commodities as recorded in the astronomical diaries, which supplement and confirm the data in these diaries. The existence of these pricelists suggests that Babylonian scholars had interest in the development of prices in their own right as well.[3]

The very fact that the prices are recorded in the astronomical diaries shows they were regarded as volatile and unpredictable and, hence, market prices. This finding is also empirically confirmed by Temin (2002) and Földvári and Van Leeuwen (*in press*). Indeed, it would have been senseless for the Babylonians to record these prices if they were set by the king. Prices were in principle like the whims of the weather, so they were recorded to research whether some correlation with other events could be detected and hence convey information on the future. For us it is strange to see the results of this science in statements of this kind recorded in collections of omens: "if the sun is surrounded by a halo, it will rain the next day" (which is a correct observation) and "if the sun is eclipsed on the western part on day x of month y, the king of Westland will die" (for which there seems to be no scientific ground). From other sources we know that the Babylonians were aware of the fact that prices were higher before harvest than after harvest and that warfare could increase prices. But other factors were at stake as well in their minds, like a relation to the constellation of the stars.

Other regions have, unfortunately, produced much less rich datasets. We use data from Rome (Rathbone 2009), Egypt and Athens (Von Reden *in press*), and Delos (Reger 1994). It is important to note that, although Egypt was well known for its supply of

[3] The astronomical diaries have been published by Sachs and Hunger (1988, 1989, 1996). The price data are collected by Slotksy (1997), Vargyas (2001), and Van der Spek (2005). For the price lists see Slotsky and Wallenfels (2009). A new list specifying daily prices, including the data of the Babylonian price lists, has been prepared by the VU University research team on Babylonian market efficiency (R.J. van der Spek, B. van Leeuwen, J.A.M. Huijs, R. Pirngruber). Records of the level of the Euphrates are also included.

Figure 1: Prices in grams of silver per hectolitre (log base 2 scale)



Source: Reger 1994; Slotksy 1997; Vargyas 2001; Van der Spek 2005; *in press*; Von Reden *in press*; Rathbone 2009.

grains (Erdkamp 2005), almost all of the few surviving price data from Egypt are from the more densely populated Greek parts. These prices are most likely higher there than in the other regions. At the same time, the data from Delos must have referred largely to the imports of grain (Reger 1994). As a consequence, they are relatively high, as can also be seen from figure 1.

A serious problem with the above price data is that they do not always refer to the same crops. The main crop in Babylonia was barley while in most of the Mediterranean world wheat was the preferred grain (although people might have eaten more barley than they were prepared to admit in the written sources). For the Babylonians there was no choice. Despite the abundance of water through irrigation, they could not grow wheat due to the salinity of the soil, an ever recurring problem in Iraq's agriculture.[4] Therefore, following Van der Spek

[4] Cf. Jacobsen and Adams 1958; 1982. Powell (1985) questioned the impact of salinization, but it was confirmed again by Artzy and Hillel (1988).

(1998: 246-253), we could argue that as the Babylonians had no choice but to consume barley, and as barley and wheat were respectively the main crops in Babylonia and Egypt, one might decide to treat them as identical, as "grain".

However, even though the nutritional value of barley *per kilogramme* is about the same as that of wheat, this is not true in litres. Due to the fact that a kilogramme of barley is more voluminous than a kilogramme of wheat, as barley grains have hulls and rachis, a litre of barley has 20% less nutritional value than wheat.[5] This seems to correspond with the finding that the prices of barley in Egypt, being the less preferred grain, were roughly 20% - 40% lower than wheat prices as well.[6] This significantly reduces the price difference expressed in kcalories between barley in Babylon and wheat in Egypt.

When comparing grain prices in Egypt and Mesopotamia one should take into account that the Egyptians could choose between wheat and barley. This must have generated a downward pressure on barley prices in relation to wheat as wheat was the preferred grain. Prices are not only determined by caloric value, but also by taste. Now in Egypt the price of barley in litres was about 60% of that of wheat and on Delos the difference varied between 40 and 20%. In modern Iraq we encounter comparable figures. In the 1950s the selling price of wheat to the consumer was 35 fils per kilo for wheat and 20 fils per kilo for barley (the prices for the producer are much lower: 20 and 10 fils respectively). The figures stem from an agro-economic study of the agriculture in the Hilla-Diwaniya area in Iraq in the 1950s by A.P.G. Poyck. It is instructive to add here Poyck's background information: "Prices of most products in the area were subject to fluctuations which can be extreme for wheat and rice, for those products are consumed in the country itself. Prices are low when stocks are abundant. The

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[5] Jursa 2010: 812 based on modern conditions. Van der Spek 1998, 251 argues that the caloric value per litre in antiquity was only 65% of that of wheat, if we assume that the hulls and rachis of the barley were not removed. In 19th century Bengal, the price of threshed barley was exactly 20% higher than that of unthreshed barley (Hunter 1876: 313).
[6] This conforms with the ratio barley : wheat = 3:5, attested in Ptolemaic Egypt (cf. Cadell/Le Rider 1997: 25; Von Reden, *in press*).

price of barley is fairly stable, because the export price of barley is regulated by the government, and hence the merchants usually follow the price fixed. For cereals prices are highest before the harvest and lowest immediately after it." [7] The modern intake of wheat, barley, rice and dates was 11.8, 40.9, 28.0 and 59.9 kilogrammes per year respectively.[8]

As the Babylonians could not choose between barley and wheat, and as barley and wheat have about the same caloric value in kilogrammes, the prices of barley in Babylonia must be scaled up somewhat when we compare them with barley prices in Egypt. Perhaps it is advisable, *ceteris paribus*, to treat the Babylonian barley prices as lying somewhere in the middle between wheat and barley prices in Egypt and Delos, hence about 80% of the wheat prices there. This corresponds to the fact that 1 litre of barley has the same caloric value as 0.8 litre of wheat.[9]

A comparison between barley and wheat is not sufficient since in Babylonia both barley and dates were consumed in roughly equal amounts. Since barley and dates have the same nutritional value per litre,[10] they can be directly compared. Nevertheless, prices do not completely go up and down in tandem. Therefore, our main focus will be on the comparison of barley and wheat. Nevertheless we also shall discuss the price volatility of dates, where relevant, below.

The above discussion of comparing prices between Babylon and other Mediterranean regions gives us some information on the relative wealth of those regions as well. Even though in Egypt people consumed the more expensive wheat, it was not necessarily richer

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[7] Poyck 1962: 59-60 and table 4.14. One fils is 1/1000 of an Iraqi dollar, which was at the time equivalent to one British pound sterling and 2.80 American dollars.

[8] Poyck 1962: 67, table 4.21. Important other foodstuffs are meat (10.5 kilo), lebon (64.2 kilo) and vegetables and fruit (58.5 kilo).

[9] Jursa 2010: 812. A litre of barley weighs about 0.62 kg, a litre of wheat 0.78 kg. The caloric value for both wheat and barley is about 3100 cal. per kilogramme.

[10] Jursa 2010: 52 and 812. 1 litre of dried dates (0.8 kg) equals 1 litre of barley (0.62 kg) in caloric value. Jursa 2008, 411, n. 160 argued on the basis of the suggestion that in ancient Babylonia the caloric content of a litre of barley was only 65% of a litre of wheat (Van der Spek 1998, 251) that the caloric value of barley and dates per *kilogramme* are roughly identical, being 2490 and 2550 cal/kg respectively. All figures remain somewhat speculative as we do not know to what extent hulls and rachis were removed in barley containers.

than Babylon since the nutritional value of wheat in litres was also higher. A possible beneficial position of Egypt versus Babylon could appear from higher nominal wages. Wages in Babylonia are within the range of 2/3 of a shekel to 4 shekels = 1.34 – 8 drachmas per month[11], while in Egypt between 260s and 250s BC wages varied from 0.083 to 0.33 drachms = 2.5 to 9 dr. per month.[12] This suggests that wage levels were not essentially different in Egypt and Babylon. The same cannot be said for Athens. In classical Athens 1 drachma per day was paid to labourers at the Erechtheion (408-7 BC)[13] and 1.5 dr. per day for unskilled construction workers in 320 BC[14], which is equivalent with about 30 - 45 drachmas per month. This stands out in stark contrast with the 8 drachmas of their Babylonian colleagues one year earlier. This implies that wheat wages must have been about equal in Babylon and Egypt, while they must have been slightly higher in Athens where a higher price was compensated for by a far higher nominal wage. Indeed, Scheidel does not find much evidence for substantial differences with Egypt. He shows that wheat wages in Babylonia varied around 6-8 litres per day, versus ca. 10 litres in Athens, between 5 and 9 for Delos, between 3 and 7 litres in Egypt, and between 6 and 11 litres for Rome.[15]

3. Market integration

As argued in the introduction, market integration (i.e. trade) can have a strong effect on market efficiency. Even though in this paper our focus is on international trade, there must have been market integration *within* Babylonia in view of the good connections via various canals and rivers (esp. the Euphrates) between Uruk in the South and Sippar in the north and

[11] The evidence for wages in Babylonia is very poor. Labourers who worked on the removal of the debris of the Esagila temple earned 4 shekels per month in a time of extreme high barley prices (321 BC); the Rahimesu archive (c. 93 BC) mentions wages between 2/3 and 2 shekels. The traditional 'ideal' price was 1 shekel. Cf. Van der Spek 2006: 291-2.
[12] Maresch 1996: 192-4; Scheidel 2010: 443.
[13] IG I^2 374 for the labourers at the Erechtheion (408-7 BC); cf. Austin & Vidal Naquet 1977, text no. 71 with comments; Scheidel 2010: 441, nn. 44-45.
[14] Scheidel 2010: 442, n. 46, with references.
[15] Scheidel 2010: 453.

Babylon in the centre. Jursa (2010: 99) observes: "It can be demonstrated that with respect to trade in the basic staples, dates and barley, institutions such as Eanna [main temple complex in Uruk – vdS/vL] operated within a system of exchange which encompassed Babylonia in its entirety. Prices valid in different regions were compared with a view towards choosing the most advantageous time and place to buy (and sell), and the shipping of substantial amounts of staples across the country was a common occurrence − transport costs and the taxation of goods in transit, while often substantial (and apparently quite varied), were normally not prohibitively high." After a discussion of the evidence he concludes that "most parts of Babylonia in the sixth century formed a single and comparatively well-integrated economic space" (p. 140). In the Neo-Babylonian and Persian period the city of Babylon was the centre of the network of trade connections. It may be assumed that in the course of the Hellenistic period this centre was shifted to Seleucia on the Tigris and the Royal Canal.

As regards the focus of this paper, international trade, it is generally argued in the literature that in Babylon, international trade in grain was limited.[16] Even though Babylonians traded in dyestuff metals, and wine in Asia Minor[17] and imported alum for dying wool, as well as luxury products, from Egypt,[18] trade in grains did not take place on any significant scale. This is not surprising since trade flows must have gone either through the desert or a long way by ship along the coast of the whole of the Arabian Peninsula, which gave grave risks for transport. Hence, only goods with a small volume and high value could be transported over long-distances, which exclude grains. Furthermore, barley is a cheaper grain than wheat (the same applies to dates as well) and is therefore more difficult to market, so that price volatility is lower for expensive grain than for cheaper varieties. Indeed, Persson observes: "The obvious interpretation is that, transport costs being additive, transport's share of the total cost of wheat is smaller than for (say) rye. The conjecture then is that wheat

[16] Van der Spek 2007: 419-425; Aperghis 2009; Jursa 2010: 224-5; 278.
[17] Oppenheim 1969: 240-242.
[18] Wiseman 1966: 155.

markets are better integrated because the barriers to trade are smaller".[19] In other words, it is even more difficult to export barley or dates than it is to export wheat. In addition, as the Greeks preferred wheat over barley, they must have been on the edge of starvation before they were to buy Babylonian grain.

The other major player in this region, Rome, was completely different. Being located close to the sea, trade with Egypt and other regions bordering the sea must have been much easier.[20] In addition, Rome was the centre of a world which was dominated by wheat consumption. Indeed, following the above line of reasoning, Kessler and Temin (2005) and Temin (2006), following Hopkins (1995/96), showed that the price of grain gets lower the further away a region is from Rome. They concluded that the price differential was caused by transport costs and, hence, that the Roman Empire thus had an integrated grain market with Rome as the centre. Although Erdkamp (2005), in view of the relatively high price volatility found in most regions of the Roman Empire, argues that markets within the Empire were not integrated. Hence, government intervention was necessary causing most grain to be paid in tribute. This, however, does not necessarily nullify Kessler and Temin's argument as long as a working market existed, which is generally accepted. Indeed, Rathbone (1997: 193; 2009: 308-9) has argued that the "variation in Egyptian wheat prices does not indicate an inadequate market but was determined principally by fluctuations in yields due to the Nile inundation and was limited by Egypt's excellent storage and transport facilities." Although Rathbone criticizes the data and model used by Kessler and Temin, he still agrees that "[w]e have seen hints of the existence of regional price levels: one in the eastern Mediterranean and another in Rome and Italy, with a fourfold differential between them which roughly accords with relative productivity and transport costs."[21]

[19] Persson 1999: 107.
[20] See also Studer (2008) for a comparable argument.
[21] Rathbone 2009: 309.

Hence, we applied the same method as Kessler and Temin (2005) to our Babylonian data. Unsurprisingly, with a positive coefficient for the distance we find that the relationship is exactly the reverse Kessler and Temin found for Rome: the further away a region is, the higher the price compared to Babylon (see Table 1). This can also be deduced from figure 1 where all series

Table 1: *Regression of price difference with Babylon on distance.*

Dependent variable: price difference region x with Babylon (in grammes of silver per hectolitre), corrected for differences wheat/barley		
	Coefficient	t-value
Distance (km)	0.120	2.19
Distance (km)^2	-0.00003	-1.95
Level dummy 150BC	-11.468	-1.47
Constant	-101.243	-1.98
N	38	
R^2	0.226	

are on a higher level than in Babylon. The possible explanation for this pattern is twofold. First, the lack of grain trade in combination with an efficient agriculture kept prices in Babylon relatively low. Indeed, it has been argued that the fertile region around Babylon was as efficient agriculturally as Egypt, which was considered the granary of the Mediterranean.[22] Van der Spek (2006) even calls Babylonia an “agricultural paradise”. This does not mean, however, that everyone was well fed. War, civil strife, extreme low or high Euphrates levels, bad land management, or a possible Malthusian type regime may all have on occasion affected the nutritional status of the population. Modern Iraq is even richer. Apart from the still advantageous conditions for agriculture it possesses huge oil reserves. In spite of that the

[22] Erdkamp 2005: 208.

majority of the Iraqi people live in poverty. At the same time, trade relations with the Eastern Mediterranean in grains were small or non-existent. Indeed, Aperghis (2009) stresses that international grain trade consisted of not more than 0.04% of total agricultural production in Mesopotamia.

Second, whereas Babylon did not dominate the international grain trade, Rome might have done. If Rome did dominate the Mediterranean grain market, which according to Kessler and Temin (2005) led to lower prices the further a region is from Rome, this implies that prices must become higher the further a region is away from Babylon, since Babylon is located on the other side of the Mediterranean world and did not affect prices in the other regions because of lack of viable trade relations.

Indeed, if we do the same exercise for Rome (see Table 2) as we did for Babylon, we find, just as Kessler and Temin (2005), a negative relationship between the grain price difference with Rome and distance. Clearly, our relationship is weaker than that found by Kessler and Temin (2005), but this may be explained by the situation that our data refer

Table 2: *Regression of price difference with Rome on distance.*

Dependent variable: price difference region x with Rome (in grammes of silver per hectolitre), corrected for difference wheat/barley		
	Coefficient	t-value
Distance (km)	-0.018	-1.74
Constant	41.298	2.57
No.	11	
R2	0.137	

to the period 275-73 BC. This precedes most of the data from Kessler and Temin and refers to a period that Rome did not wholly dominate the Mediterranean world. Yet, we do find that the price gap between Rome and the other regions slowly increased over time, explaining its increasingly dominant position and the stronger relation found by Kessler and Temin (2005).

In sum, it seems that Babylonian long distance trade was limited, while for Rome, not being a land-locked region, this applied much less. Indeed, a similar relationship between location and trade activity has also been found in a comparison between India and Europe in the 18th century by Studer (2008: 406) who argues that the findings in studies of Jacks (2004) and Shuie and Keller (2005) of much higher market integration in Europe are largely because in those studies markets are chosen that are located close to waterways, which facilitates transport.

4. Price volatility and trade

Babylonian markets thus seem less connected with other markets around the Mediterranean. Theory predicts that if markets are unconnected, price volatility is caused by local demand and supply factors only. Most importantly, price fluctuations are driven by the annual harvest. On the other hand, if markets are perfectly related, one would expect the price fluctuations to be completely independent of the local harvest since any excess supply or shortage is made up via trade. This process will mitigate price fluctuations. Hence a high volatility of prices is an indicator of low market integration[23], while any remaining price difference in different regions is caused by transport costs.

The standard way of calculating volatility is the Coefficient of Variance (CV). The coefficient of variance is level independent, since this is the standard deviation divided by the

[23] Cf. Persson (1999).

mean. Unfortunately, the CV might be influenced by the number of factors not related to market efficiency. Therefore, for Babylon we included only those observations that overlap

Table 3: *Coefficient of variance by region*

Region	Product	Time	CV
Babylon	Barley	385-74 BC	0.62
Babylon	Dates	385-73 BC	0.48
Egypt	Wheat	330-99 BC	0.68
Athens	Wheat	385-300 BC	0.59
Delos	Barley	282-174 BC	0.28
Rome	Wheat	385-72 BC	0.54

Source: Reger 1994; Slotksy 1997; Vargyas 2001; Van der Spek 2005 and an expanded list in preparation; Von Reden in press; Rathbone 2009.

with prices from Egypt (the second most abundant dataset). The data for the other regions are so infrequent that we have to take them at face value. However, there is no specific reason to believe that they are non-random and, therefore, we do not expect a bias.

From the above table it becomes clear that the volatility of grain prices around the Mediterranean Sea is much lower than in Babylon. Dates are, in this respect, not comparable since dates are much less susceptible to bad weather conditions and, hence, their price volatility is much lower. This is a common pattern that can be seen even today. It needs to be stressed that the only exception to lower CVs for barley/wheat in the Mediterranean world is Egypt, which seems marginally higher than Babylon. Yet, this may be explained by the situation that Egypt does have a grain export, but no import. In addition, as pointed out by Van Leeuwen, Földvári, and Pirngruber (2010), the CV in Babylon is lowered by the existence a dual crop structure of barley and dates. Since wheat is more volatile than barley, since dates are much less volatile because of the way in which they are grown, and volatility in barley prices is reduced because of the substitutability with dates, over-all price volatility in Babylon is expected to be lower than in Egypt.

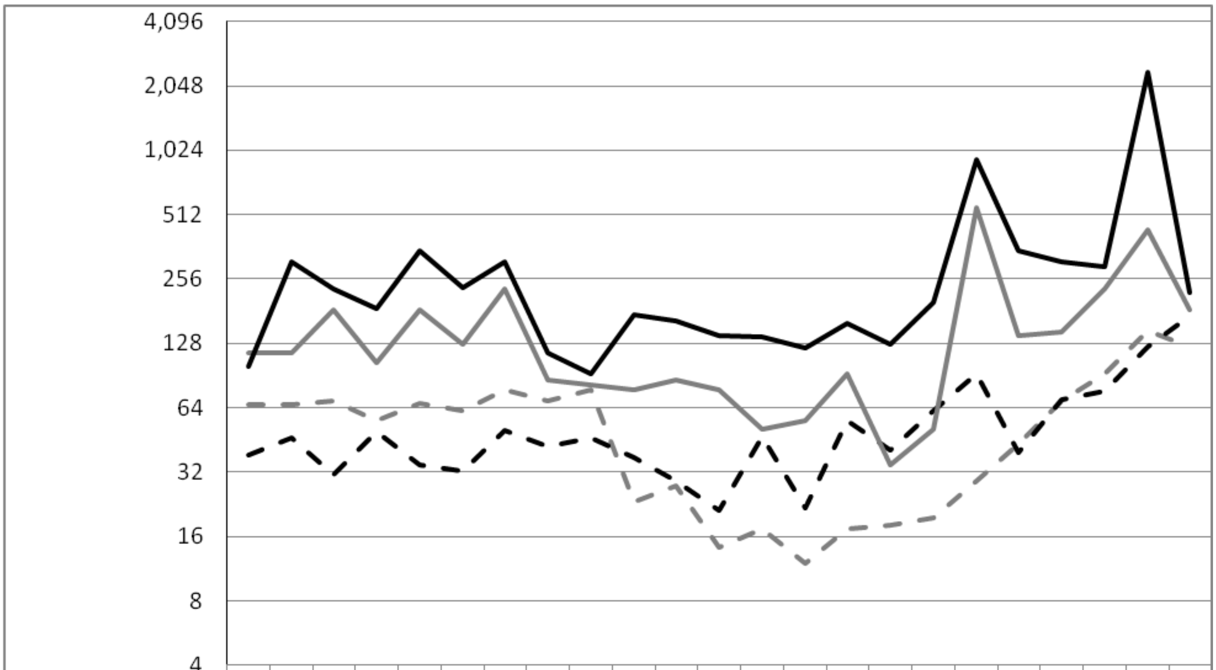
Indeed, the CV in Babylon is remarkably high given its dual crop structure with barley and dates. This may be explained by the lack of long distance trade. In addition, the consumption levels in Babylon were probably also quite low, making prices increase fast in times of famine and thus increasing volatility. When we look at the price data in the astronomical diaries we see famine occurring at 36-39 litres per shekel = 213.6 - 231.4 grammes of silver for 1000 litres of barley.[24] This happened in about 7% of the years for which we have information. Van Leeuwen, Földvári, and Pirngruber (2010) show that, with this famine frequency and a small harvest carryover, the famine line must be around 90%. Hence, a crop failure of 10% would already result in famine, which means that Babylon cannot have been far above subsistence level. The relatively low variance in output, however, made sure that famines are relatively infrequent. Indeed, as argued by Ó Gráda (2007: 8), famines in historical societies were not that frequent since "given that life expectancy was low even in non-crisis years, frequent famines would have made it impossible to sustain population."

The above pattern applies to both barley and dates. Indeed, during years with famine prices for barley we find that in c. 20% of the instances also date prices exceed the famine level (assumed the same as for barley, since they have about the same nutritional value) as well. This is not surprising since barley and dates prices in general move together. This can also be seen in Figure 2 below, where we have collected the highest and lowest prices of the period 299 – 61 BC by decade. The period is chosen to skip over the extreme high prices of the period of Alexander the Great and his early successors, a very unstable period with destructive warfare. Furthermore, from 321 – 311, a whole decade, we have no diaries at all!

[24] Grainger 1999; Van der Spek 2006: 295.

Hence, presenting an overview of the ranges between high and low prices per decade gives us an equal number of price data in every

Figure 2: *Highest and lowest date and barley prices in grammes of silver per 100 litres (log base 2 scale)*



	299	289	279	269	259	249	239	229	219	209	199	189	179	169	159	149	139	129	119	109	99	89	79
lowest dates	66	66	69	56	67	62	77	69	77	23	28	14	17	12	17	18	20	29	44	69	92	147	123
lowest barley	38	47	31	50	35	32	50	42	47	37	29	21	47	22	56	40	62	92	40	69	77	123	172
highest dates	116	116	185	104	185	126	231	86	82	77	86	77	51	56	92	35	51	554	139	146	231	437	185
highest barley	99	309	231	185	347	232	309	116	92	174	163	139	136	121	159	126	198	926	347	308	292	2,380	220

Source price data: see references under Table 3

decade. As we have from some years six or more prices and from other years only one or none, it would give a distorted picture to lump all these prices together and base calculations on this.

What can we deduce from these figures? Both dates and barley exhibit a large degree of volatility between the highest and lowest prices within a decade. The volatility for barley is the highest, ranging between 22 and 2380 grammes of silver per 1000 litres. The second observation, which is easily made, is that for both the barley and dates, prices were higher in the Parthian period and that the range between highest and lowest prices was larger too. Evidently, however, the figure of the Parthian period is much distorted

Table 4: *The range between highest and lowest prices (prices in grammes of silver per 1000 litres)*

	Barley	Dates
Range lowest – highest prices within one decade	119 – 5,871	28 – 874
Average range	**674**	**159**
Range lowest – highest prices **Seleucid** period	119 – 813	28-256
Average range **Seleucid** period	**347**	**101**
Range lowest – highest **Parthian** period	355 – 5,871	53 – 874
Average range **Parthian** period	**1,331**	**290**
Factor average lowest > highest price	9.16	4.26
Factor **Seleucid** period	8.05	3.50
Factor **Parthian** period	11.60	6.01

Source price data: see references under Table 3.

by the extremely high price in the 89s. Yet, on average, as may be expected given the less volatile harvest of dates, the range is both in the Seleucid and Parthian period much smaller than for barley.

All in all it seems that the **range** of highest and lowest prices of barley is higher than that of dates, which concurs with the much lower CV of dates. The explanation is that the date harvest is less susceptible to the whims of the climate. The stability in the relation between high and low prices of dates is much stronger than that of barley, in the entire period. The variability is thus strongly related to famines. Indeed, we can see that the higher volatility and price level of the Parthian period is easily explained by the fact that the Parthian period was politically very unstable. Warfare, insurrections, and invasions of Arabs were the order of the day.

Since both crops were main staples, their price trends do not differ much and they can be considered each other's substitute, i.e. when the price of one product rises, the demand for the other product will increase. The relative decline of date versus barley prices after ca. 220

BC suggests that there either was a strong increase in the production of dates combined with a relatively low substitution between dates and barley, or exogenous factors lowered the price of dates. There is no definitive proof as to why this happened but several suggestions have been brought forward. Some authors have focussed on the role of climate, or salinization while others have stressed government policies that promoted date gardens, or hypothesized a reduction of taxes on dates.

An increase in date gardens has been argued for by Van der Spek. This increase may have been the effect of a royal law, attested in 221 BC, in the reign of Antiochus III (222-187 BC), which promoted the planting and cultivation of dates[25]. Aperghis (2008: 84) has argued against this explanation based on the argument that the fall in date prices was too fast for an increase in the number of date gardens to have had an effect. He hypothetically attributes the fall in prices to a tax reduction by the king (this volume?). Indeed, we know that the effect took place in only a few years between September 208 and March 205 BC while date palms need several years before they bear fruit. However, the royal law stems from 221 BC or earlier, which is in itself long enough for the new date gardens to become productive.

A third explanation may be climatic. Some authors have argued that salinization of the soil took place in Babylon. [26] It could be argued that the Babylonian lowlands were especially prone to salinization due to worse drainage in the period after 200 BC while dates were less sensitive to salt than barley, hence increasing the relative supply of dates. This argument seems implausible though, since it would create an overall increase in the prices which we do not find back in the data. Jursa observed that a similar lagging behind of the rise of date prices after the rise of barley prices occurred earlier, between 540 and 500 BC. He argued that a shift from cereal agriculture took place in favour of horticulture, which made price of dates lower

[25] Van der Spek 2004: 322. The evidence is a lease contract in perpetuity concerning a tract of temple land in Uruk with the obligation of planting date palms, mentioning a *diagramma*, "ordinance", of the king (Van der Spek 1995: 227-234, text 7: 34 and 38). The fact that in line 34 the term *diagramma* is translated as "the decree (*ṭè-e-mu*) that the king issued," suggests that the ordinance was issued only recently.
[26] Jacobsen and Adams 1958; 1982; Artzy and Hillel 1988.

and of barley even more volatile.[27] This does not seem to correspond with a salinization hypothesis. However, around 200 BC there are large fluctuations in several indicators of rainfall and vegetation in the Middle East.[28] This suggests that this relative decline in date prices may be caused by climatological factors. However, much more research is necessary to prove any of these arguments.

5. Duration of high prices

Clearly, famines seem to have been relatively frequent and could only have been relieved by trade within Babylonia. It is to be expected, however, that exogenous shocks which affected the city of Babylon were in most cases felt across the entire region. Substantial trade from outside this region is hardly possible, as we pointed out above. A clear indication of this is the duration of high prices. After all, without trade, if a harvest failed, one would expect high prices also in the next year(s) since there was also lack of seed. However, if trade existed, one would expect periods of high prices not to last very long. In other words: was the Babylonian economy able to recover quickly from a period of high prices, or did high prices have a lasting effect?

In the literature, there has been a focus on extremely high prices, close to famines, as opposed to moderately high prices.[29] Since, as we noticed before, barley is much more subject to volatility than dates, we will start with barley (see Table 4). Even though the figures of some of these periods are suspect as they are written on damaged parts of the tablets or may be due to a scribal error, they still provide a useful overview. The main conclusion is that, with one exception, the longest possible

Table 4: *duration of high barley prices in months*

[27] Jursa 2010: 451-468.
[28] Cf. Wick, Lemcke and Sturm 2003.
[29] For a full overview see Van der Spek *in press*.

Period of recorded peak prices	Min.	max.
1. May 286 – February 285	10	22
2. December 282 BC *	1	1
3. October 274 – March 273	6	67
4. Dec. 266-May 264 **	12	45
5. June 257 – October 256	18	63
6. October 248 ***	1	18
7. Aug. 241 – March 240	7	48
8. September 235 – Feb. 232	30	84
9. April 208	1	12
10. October 194 – Feb. 193	5	36
11. February 180	1	17
12. Dec. 178-Jan. 177	2	56
13. August 155	0.33	18
14. August-Sep. 145	2	124
15. Aug. 139-May 138	9	9
16. Oct. 138-Mar 136	17	36
17. March 126 – August 124	27	78
18. April 83 – January 82	10	14

* Might be due to the preparation of Seleucus I's last campaign.

** Actually two periods of 5 + 7 months. There was a brief recovery in June, apparently thanks to the harvest.

*** Price difficult to read on tablet, but probably correct.

Source: Van der Spek (*in press*)

duration of high prices was at least nine months (139-8 BC), but in most cases much longer. That one exception (282 BC), if not a scribal error, can possibly be attributed to Seleucus I's preparations for his last campaign. Also another possible period with high prices with a minimum duration of one month in October 248 might be misread as the number is somewhat damaged. Hence, removing these two potential outliers in 282 and 248 BC, we can calculate on the basis of Table 4 that the *average* duration of extremely high prices is somewhere between a minimum of 9 months and a maximum of 3.5 years.[30] It is important to note

[30] It may be advisable to treat the Seleucid and the Parthian period separately since the Seleucid period may be considered the more stable period. The Seleucid period as a matter of fact contains 14 periods of extremely high prices of one to three years in 160 years. The minimum average of the Seleucid period is 7.6 months if we

though, that the two instances with a minimum duration of 2 months in Table 4 belong to the observations with the widest interval between the minimum and maximum duration in this dataset and, hence, the highest unreliability. If we assume the duration figures are distributed at random, the average expected duration is certainly well over a year.

In Table 5 we present the same information for the second main crop: dates. However, because of the wide gaps between the minimum and maximum duration of high prices caused by lack of data, these observations are less useful. Yet, again it points at an average minimum duration of high prices of slightly less than a year and a maximum duration of several years: in the Seleucid period, the average duration of high prices was between 3 months and slightly over 4 years, while the same numbers for the Parthian period are difficult to assess as the period between December 128 to December 126 was period of continuous high prices with two excessive peaks and from April 96 the prices rose suddenly considerably with a peak in April 83.

Table 5: *Period of high dates prices (months)*

Period of peak prices	min	max
1-29 March 270	1	60
April-May 258	1	15
June 257 – May 256	12	27
November 233 – January 232	3	41
August - September 159	2	30
February 154	1	132
May-June 127	1	12
December 127 – Feb.126*	3	4
Apr-83	1	17

remove the outliers of 282 to 258 BC and 6.6 if we take all numbers at face value. The maximum duration is on average 43 months or 36 months if we take item 14, concerning year 145 (after a period of 10 years with no data), as being of no relevance. The maximum duration increases even to 42 months if we remove also items 2 and 6 as outliers. For the Parthian period both the average minimum –and maximum duration of high prices is with 15 and 34 months considerably longer. This means that the situation in the Seleucid period is somewhat better. If we assume that the figures are distributed at random, the average duration of high prices was in most cases more than one year. In the Parthian period it was certainly well over one year.

Source: Van der Spek, Vienna

* December 128 to December 126 was a period of high prices with two excessive peaks.

It seems that for both barley and dates the average expected duration of high prices is on average more than 9 months, possibly even 3 years. Unfortunately, it is hard to address the question whether this duration is long since in the literature on Babylon the focus so far has largely been on extreme prices and not so much on the duration of "high prices", which is more commonly researched in other literature. Yet, if we compare the data in Tables 4 and 5 with extreme barley prices in Pisa (1548-1590) (Malanima 1976) and extreme rice prices in Jakarta (1824-1850) (Van Zanden 2004), where extreme prices are defined as at least 30% above average and the duration is calculated as the period when the prices are at least 20% above average, we find that the average duration of high prices is 8.9 and 9.4 months respectively. Hence, the average expected duration in Babylon seems to be on the high side. This is especially true because of the dual crop structure in Babylon. Since the output of barley and dates is negatively correlated (e.g. a lower barley output seems often to go hand in hand with a higher dates output), in order for the duration of high prices to be so long there must really have been a catastrophic collapse in output. It is possible to relate this finding to the results from Van Leeuwen, Földvári, and Pirngruber (2010) who computed a high famine level and argued for a lack of storage for harvest carry-over. This means that if there was a bad harvest, prices in Babylon remained high for a relatively long time in the future, or in statistical terms, they are autocorrelated.[31]

As the information on the length of the peak periods is rather lacunose, it may help to take a look at the periods of recovery after the latest month of high price. Tables 6 and 7 show that the recovery must on average have been between 1 and 12.6 months (or 14 months if the

[31] Cf.Temin 2002; Földvári and Van Leeuwen *in press*.

data of 281 and 248 are left out). However, even though there is not really enough information available, one might cautiously conclude on the basis of above tables that the longest durations of the decrease of extremely high prices to normal prices always took place after the harvest. If we look at barley in table 6 (we do not have data for dates early in the year), most of the maximum recovery periods longer than a year take place after the harvest (c. October). This suggests that in most cases at least the next harvest has to be awaited before prices start to decline again. Similarly, the short recovery periods almost all happen at the start of the year around the barley harvest (April/May). This suggests that the return to the normal price is largely dependent on new harvests rather than on external imports in between harvests. It must, however, be taken into account that extreme prices by definition did not last long since a long-lasting famine implies massive mortality.

Table 6: *Maximum recovery periods after peak prices (barley)*

Month of recovery to normal price	**maximum number of months**
February 284 BC	12
January 281	1
October 271	30
June 265	1
October 262	17
May 254	18
December 248	2
June 238	26
September 231	17
May 208	1
August 192	17
March 180	1
November 174	46
February 154	5
August 144	11
May 138	3
September 135	17
April 123	12 (gradual fall over a year)
April 82	3 (but still high)

Note: it is theoretically possible that the time of recovery in all cases was 1 month.
Source: calculated on the basis of the sources under Table 3.

Table 7: *Maximum recovery periods after peak prices (dates)*

Month of recovery to normal price	maximum number of months
October 266	52
May 258	0.5
August/September 256	3
April 231	14
August 158	12
August 145	112
November 127	5
April 126	1 (gradual fall of 12 months after this)
December 83	7

Note: it is theoretically possible that the time of recovery in all cases was 1 month.
Source: calculated on the basis of the sources under Table 3.

Therefore, it may be argued that it is more profitable to look at the duration of normal periods of high prices.

The above analysis is preliminary and much more analysis is needed to make definitive claims. Due to the fact that we only have grain prices from the city of Babylon and thus cannot compare prices with other cities such as Uruk, Sippar and Seleucia on the Tigris, we can hardly see if there was good market integration within Babylonia. As pointed out by Jursa, market integration in the 6th century BC was rather good, but this cannot be a priori postulated for the Hellenistic and Parthian periods because the political role of Babylon had changed considerably. There is at least one text which supports the idea that grain was transported to Babylon in a period of famine. The diary concerning month I, 229 Seleucid era = April 83 BC, mentions extreme high prices for barley, with on some days no supply at all with only "barley on the road (*ina ma-lak*) 3.5 litres". This may refer to imported grain.[32]

However, our tentative conclusion is that not only the recovery from extremely high prices largely seems to take place by means of new harvests instead of trade, but also that during periods of high prices trade did not seem to be able to lower prices in Babylon.

6. Conclusion

[32] Sachs and Hunger 1996, no. -82A obv. 14'-15'; cf. Van der Spek and Mandemakers 2003: 529-530.

It is clear that, without having a much more thorough knowledge of the Babylonian economy in this period, much has to remain speculative. Many aspects remain to be examined, like the role of transport, climate, war, comparisons of prices of barley with those of other agrarian products. However, combining all currently available evidence, it is possible to create a picture where, although each individual building block may be questioned, all blocks together constitute a coherent structure.

We find that Babylon had a limited long-distance trade. Applying a regression analysis of price difference on distance, we find that the price actually increases the further a region is away from Babylon. This suggests a lack of trade with Babylon. Indeed, like Kessler and Temin (2005), we find a weakly negative relation between distance and prices in Rome. This suggests that Rome was indeed the urban centre of the Roman Empire and it also suggests that extensive trade (and/or tribute) relations existed around the Mediterranean Sea. Babylon, however, was located far away from direct sea or land trade routes. In addition, it produced largely barley (because of salinization of the soil) which was the less preferred grain around the Mediterranean. The price in Babylon remained relatively low, however, because of its productive agriculture and because barley has less nutritional value per litre than wheat.

This lack of trade meant that markets were more sensitive to external shocks. Markets could not cope with external supply or demand shocks by means of imports (or exports). This increased volatility, as described by Persson, means less efficient markets. Indeed, we find that coefficient of variance was higher in Babylon than elsewhere, indicating less efficient markets.

We can see this effect more clearly if we also take account of the duration of high prices. We find that both barley and dates, the duration of high prices varied between 1 and 124 months. However, the expected average duration was considerable, varying between 9.5 months and 3.5 years. This suggest that often there may be autocorrelation, that is that bad harvest in year *t* may lead to a bad harvest in year *t+1* because of lack of storage and lack of seed.[33] Equally, recovery to normal prices seems largely to take place during a harvest instead of in between harvests. Hence, the relatively long duration of high prices and the lack of recovery in between harvests suggest the absence of substantial imports. Quick recovery was possible, though, and this must be related then to the fertility of the land, which allowed abundant harvests, and not to imports from afar. On occasion relief could be effected by short distance trade (e.g. from Uruk or the Diyala region) if famine was caused by a very local problem which only affected the city of Babylon and its close environment.

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[33] Cf. Temin 2002; Földvári and Van Leeuwen *in press*.

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